Travel Behaviour Dynamics:

A Mobility Biography Study towards Change

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Travel Behaviour Dynamics: A Mobility Biography Study towards Change

by

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Declaration

I, Eric Adjei, declare that the contents of this thesis are entirely my own work, except for the specific and acknowledged references to published work of others made in the text.

I declare that this thesis is my own work and that it has not been submitted before for any degree or examination in any other university, and that all sources I have used or quoted have been indicated and acknowledged as complete references

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Abstract

Travel demand management (TDM) strategies continue to receive attention in recent years as a means of managing congestion in cities and promoting more sustainable transport systems. Most TDM measures focus on effecting travel behaviour change amongst commuters. Clearly such measures are likely to have the greatest impact when targeted at commuters most receptive to changing their travel behaviour at the right time. The study of commuters in order to understand their travel behaviour patterns, when they are most open to change and what causes them to change, is therefore imperative in drawing up effective TDM strategies. Also important is identifying the period within which commuters are deliberating and seeking information in order to change their mode of transport.

Many studies have been conducted, in various contexts, to understand the dynamics of travel behaviour change. Some studies have argued travel behaviour to be rational, thus, an individual engage in active deliberation when ever there is a mode use choice decision problem. These studies suggest variability in travel patterns. Other studies have argued travel behaviour to be habitual in nature and characterised by non-deliberative repetition travel decisions. They argued that deliberate reappraisal of travel choices generally occur when triggered by 'key life course events' or 'life shocks'. Such habitual behaviour suggests fairly stable travel patterns in a city's transport network. The process through which the individual goes through in making a mode use change decision when triggered by 'key life course events' however remain largely unexplored.

This study, through the use of a qualitative mobility biography survey, firstly investigated the proposition that commuters in Cape Town engage for long periods of time in non-deliberative habitual mode choice behaviour while exhibiting considerable levels of intra-personal variability. These non-deliberative habitual mode use choice behaviours were posited to change when infrequent key life course events or incidents induce deliberation. Average duration between mode use changes among commuters was found to be about six years, confirming the habitual nature of mode use choice – especially among private vehicle users. Variations were, however, found in other attributes of travel choices such as departure time and route choice. Changes in mode use were observed to be in all directions, with the net change over the long-term being from public to private transport – an indication of 'asymmetric churn'. Key life course events found to cause mode use changes included changes in employment, changes in residential location and car ownership.

The study then investigated the process a commuter goes through in making mode use changes when experiencing one of these three major life course events. The time when commuters start to deliberate on mode use change and seek information was investigated. Commuters were found to start deliberating on mode use changes and seek information about thirty and twenty-five days before the life course event occurs respectively and stopped about a day after. Information sought after during deliberation included; operational cost, comfort, travel time, convenience of mode use and safety. Commuters, however thought more about what they would gain by changing mode rather than what they would lose.

The study concludes by recommending travel demand management strategies to be targeted at commuters that are about to experience a life course event and not after, as it may be too late. Information aimed at changing mode use choices from private to public transport should lay emphasis on what commuters would gain by changing to public transport rather than what they would lose. Information such as travel cost, travel time, convenience, safety, environmental and health impacts may be included in the design of information packs.

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Last but not the least, I am grateful to my family for supporting me in all aspects of my life. To my mother, Lydia Boateng, my wife, Afua Appea, I say thank you for your support. To my baby girl, I dedicate this work to you.

Table of contents

List of figures

List of tables

List of Acronyms

BRT	Bus Rapid Transit
CBD	Central Business District
CDT	Cognitive Dissonance Theory
EHC	Event History Calendar
GABS	Golden Arrow Bus Services
GST	Goal Setting Theory
HFT	Habit Formation Theory
LCE	Life Course Event
NAT	Norm Activation Theory
PBC	Perceived Behavioural Control
PT	Prospect Theory
RCT	Rational Choice Theory
SA DoT	South African Department of Transport
SCM	Stages of Change Model
SPT	Self-Perception Theory
TBC	Travel Behaviour Change
TDM	Travel Demand Management
TIB	Theory of Interpersonal Behaviour
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
VTBC	Voluntary Travel Behaviour Change

Chapter 1. Introduction

1.1. General Introduction

Transportation involves the movement of people and goods between activity points. It has a direct impact on the development of a city and country as a whole, both socially and economically (World Bank 1996; Murray, Davis *et al.* 1998; Gwilliam 2002). A good transportation system promotes development, sustainability and equality. The continual increase in the use of private cars – which typically have a low occupancy rate – however, leads to increase in congestion on the roads given a constant road capacity. Increases in congestion have been related to undesirable effects such as increase in traffic crash rates, noise pollution, air pollution and increase in fuel usage (Gwilliam 2002; Martens 2004; Beirão and Sarsfield Cabral 2007; Banister 2008). It also increases travel times and delays, restricting inhabitants' mobility between activity points. These hamper city development – socially, economically and environmentally.

It is therefore of no surprise that efforts in reducing congestion on our roads have been of major concern for most transport planners and city managers alike. Conventionally, transport planners have resorted to the construction of new roads or the expansion of existing roads as a means to managing congestion (Owens 1995). These supply-side strategies have, however been seen to solve the problem of congestion only for a short term as they induce more traffic, in particular car use in the long term (Owens 1995; Goodwin 1996; Litman 2001; Noland 2001; Gwilliam 2002; Tiwari 2002). The long-term failure of this unsustainable policy – predicting and providing for traffic – has led to a shift to more sustainable policies centred on travel demand management (TDM).

Travel demand management (TDM) involves the application of policies aimed at changing peoples travel behaviours in order to reduce the demand for single occupancy car ridership, and to effect shifts toward public and non-motorised travel mode use. These range from strategies such as spatial planning of activity locations, the provision of alternative modes of transport, creation of awareness and the formulation of policies such as flexiwork, tele-work *etc* (Anderson, Kanaroglou *et al.* 1996; Meyer 1997; Badoe and Miller 2000; van Wee 2002; Litman 2003; Loukopoulos 2007; Gordon 2008). There have been several classifications of TDM strategies by different authors (see Litman 2003; May, Jopson *et al.* 2003; Loukopoulos 2007). Among them is Steg (2003), who grouped the strategies into two broad categories – structural and psychological. Structural strategies comprise of physical changes, financial-economic stimulation and legal regulations, aiming at changing the context within which a decision is taken. Mode use changes arising as a result of structural strategies are mostly non-

voluntary even though decisions are sometimes left to the individual. Psychological strategies on the other hand involve the provision of information and education aimed at changing perceptions, beliefs, attitudes and values through the creation of awareness. These psychological strategies may also be deemed voluntary measures as mode use changes are left to the discretion of the recipient without external stimuli.

1.2. Research Problem

Private car modal share in most African cities may not be as high as that of European and American cities and this may be partly due to the low economic status of most African cities. Income levels have been observed to correlate positively to car ownership and use, even though non-linear (Button, Ngoe *et al.* 1993; Dargay 2001; Dargay, Gately *et al.* 2007; Ecola, Rohr *et al.* 2014). This is no different in the case of South Africa, where increase in income increases the potential of car ownership (Figure 1-1). Car ownership has been observed to increase rapidly among middle-income earners. Button, Ngoe *et al.* (1993) argued car ownership may increase at any given income level over a period of time. Car ownership is thus bound to increase in the future even if income levels do not increase. Private car ownership is therefore expected to increase rapidly in the coming years as economic fortunes of most African countries increases. Without the provision of appropriate TDM strategies, private car use is also expected to increase.

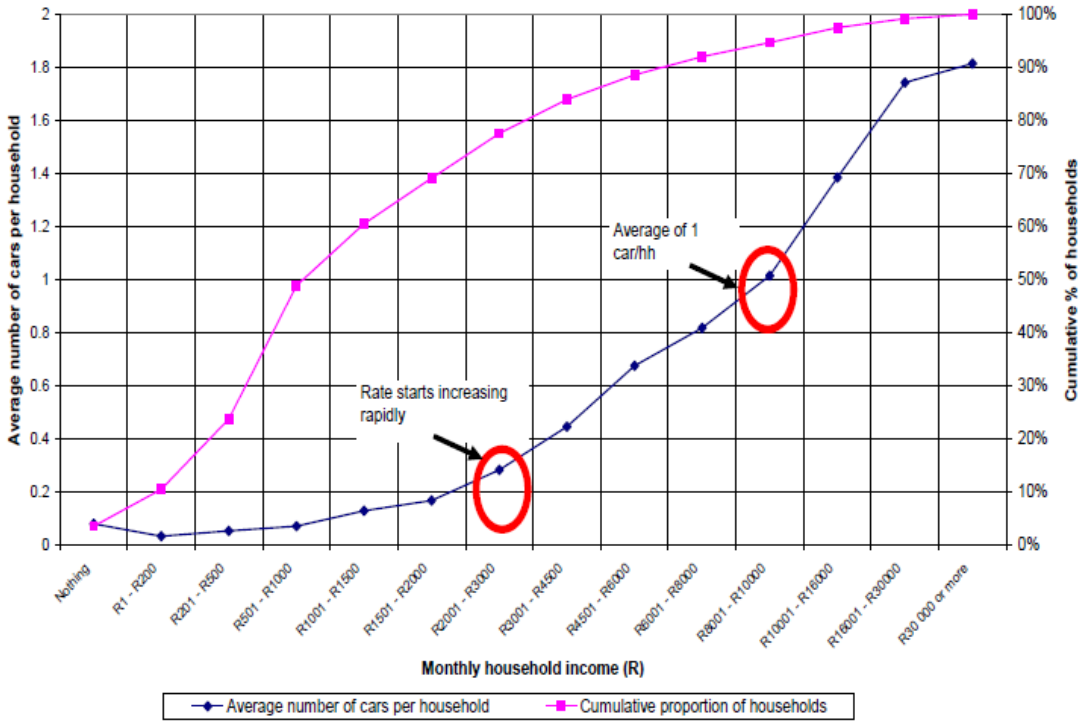


Figure 1-1: Household car ownership against income (SA DoT 2012 p. 42)

Like in other African cities, car ownership and usage in Cape Town is on the increase. The city's car ownership as reported through the number of vehicles registered as light passenger vehicle has been growing at an approximate rate of about 2-4% a year from 2001 to 2013 (Transport for Cape Town 2013; Behrens, Adjei *et al.* 2015). This growth trend in traffic volumes has led to some undesirable side effects on the city such as: congested roads resulting in increase of the peak period to about three hours, increase in crash rates, noise and air pollution (City of Cape Town 2009b). This trend in traffic volume increase over the years is reflected in the congestion index as reported by TomTom International BV (2018) over the years. They have reported an increase in congestion level – defined as the delays experienced by drivers as compared to the free flow travel time – from 24% in 2011 to 35% as of 2016. Delays were reported to be 75% and 67% of free flow travel time in the morning and evening peak hours respectively.

Data from the National Household Travel Survey (NHTS) carried out in 2013 revealed usual work place and educational institutions as major generators of trips, contributing about 34% of all trips made, including trips to home. Excluding trips to home (which include trips from all generating points) revealed work and education as the major trip generators, contributing about 56% of all trips in Cape Town (Table 1-1).

Table 1-1: Proportion of trips by purpose (based on NHTS 2013 data)

Trip Purpose	Total Number of Trips	% (including home trips)	% (excluding home trips)
Usual work place	3236	19	31
In the course of work/business	479	3	5
To take someone else somewhere	496	3	5
Educational institution	2584	15	25
Shops	955	6	9
Looking for work	262	2	3
Traditional healer	166	1	2
Church	427	2	4
Home	6937	40	
Other trips to facilities	421	2	4
Total (including home trips)	17264	100	
Total (excluding home trips)	10327		100

To pursue a more sustainable transportation path for the city and reducing negative impacts of transport, the city developed a Travel SMART programme (www.capetown.gov.za/en/TravelSMART) - aimed at assisting large employers to encourage their employees to use more sustainable modes of transport – as part of its integrated transport plan (The Sustainable Transport Unit 2012). Included in the city's vision is the provision of a transportation system that provides for the mobility needs of the economically disadvantaged, discouraging the use of unsustainable modes of transport such as private cars (single occupancy vehicles) and promoting the use of public and non-motorised transport. Transport demand management (TDM) strategies may thus be of importance in the promotion of public and non-motorised transports.

TDM strategy formulations – especially those involving voluntary measures – have been seen to be difficult tasks. This is so because of the variety of factors affecting behaviour and the difficulty in

changing behaviour itself (Jackson 2005). TDM measure transferability from one city to the other is also limited due to the difference in city and its inhabitants' characteristics. For a TDM strategy to be effective in changing behaviour, it should incorporate factors that influence the targeted behaviour (Steg 2003; Jackson 2005). In view of this, adopted TDM strategies should be contextualized, taking into consideration the factors influencing car use and preventing public transport use in its formulation and implementation. A robust understanding of the dynamisms of travel behaviour – how choices are made, what factors influence choice, when change occur and how people respond to interventions – are therefore necessary in the formulation of appropriate TDM measures.

TDM strategies, in the African context should not only aim at changing behaviours from car to public transport use but also aim at encouraging the continues use of public transport even if passenger economic status increases.

1.3. Research Objectives and Questions

The research had two main objectives. The first objective was to test the proposition that commuters in Cape Town engage for long periods of time in non-deliberative habitual mode choice behaviour while exhibiting considerable levels of intra-personal variability. These non-deliberative habitual mode choice behaviours are posited to change when infrequent key life course events or incidents induce deliberation. This establishment of the habitual nature or variability of mode use choice is useful in the formulation of TDM strategies as they determine who strategies should be targeted to, when and the duration for which they should be applied.

The second objective was then to gain empirical insight into the dynamics of habit breaking events. That is to understand the process of mode use changes when triggered by the occurrence of a life course event. This was to look at the time when commuters started thinking about making changes to their mode use choice and when they actually changed the mode in relation to the occurrence of the life course event. This was deemed helpful as it will help in determining at which point in the process of experiencing a life course event, TDM strategies should be applied for it to be more effective, and what the nature of these TDM strategy interventions might be.

Answering these two main objectives would then help in making recommendations towards the formulation and implementation of more effective TDM strategies in Cape Town.

1.4. Study Area

The study is concerned about how commuters go about changing their mode use when triggered by the occurrence of a life course event. The study is with the aim of proposing measures for the effective design and implementation of TDM measures. These measures are to effect changes towards the use of public transport. An effective public transportation system is a necessity to ensure such change especially when voluntary TDM measures are being employed. The availability of alternative modes of transport to car use was therefore a major criterion in the selection of a study area. Cape Town was chosen for the study because of the availability of relatively large network of public transport services.

1.4.1. Physical Characteristics

The city of Cape Town; one of the eight metropolitan municipalities in South Africa is the legislative capital, housing the seat of national parliament. It is the most populous city in the Western Cape and the second largest city in South Africa after Johannesburg according to the 2011 census data with a population of about 3.7 million. Not only is it the largest city in the Western Cape but also a major economic hub in the province and the nation at large (Western Cape Provincial Government 2007).

The city of Cape Town, located at latitude 33°55', and longitude 18°25' is the most southern city in South Africa, covering a total area of about 2479km^2. The metropolitan area is connected to the north by the West Coast district municipality; the east by the Cape Winelands district municipality and southeast by the Overberg district municipality with well-connected road networks.

To the south-western part of the city is situated the Table Mountain with levels rising about 1080m above sea level and chains of mountains running more than 50km southwards along the Peninsula (Wilkinson 2000).

1.4.2. Public Transport in Cape Town

Public transport services in Cape Town are provided by Metrorail, Golden Arrow Bus Services (GABS), MyCiTi bus service, minibus taxi operators and metered taxi services. They are responsible

for carrying about 48% of trips – excluding walking as main mode – according to the 2013 household survey (Royal Haskoning DHV 2014).

Mini-bus Taxi

Mini-bus taxi is an unscheduled public transport services provided in Cape Town. They are privately owned, operating along 565 routes approximately (Royal Haskoning DHV 2014). There are two types of services – route-based and area-based. Route based services run mainly between residential areas and places of employment whiles area-based services run within residential areas.

Metered Taxi

Metered taxis provide charter service to commuters in Cape Town. Taxis are usually stationary at allocated stops and are not allowed to run around the city in search of passengers. Taxis are predominantly owned by large companies and operated from a control room. Some of these taxis, are however, owned by individuals. Fares are charged per kilometre and may differ slightly from one company to the other or individual to the other.

Golden Arrow Bus Services

Golden Arrow Bus Services (GABS) provide scheduled conventional bus services to commuters in Cape Town running along about 1300 routes with a fleet size of 1046 buses (GABS). Ticketing system is mostly paper based. Passengers have the option of buying weekly and monthly tickets, which usually come at a discount. Travel fares can also be paid for by cash, but are usually more expensive. GABS however have plans of automating fare collection by using smart card system, with a possible integration with MyCiTi bus fare systems (GABS 2016)

Metrorail

Metrorail operates commuter train services in the city for the Passenger Rail Agency of South Africa; PRASA (Transport for Cape Town 2013). The train coaches have two classes of operations – MetroPlus and Metro. MetroPlus is considered as the first class and has more comfortable seats compared to the Metro, which is considered as a third class. The rail has four service lines in the city: the Northern Suburbs, Cape Flats, Central and Southern Suburbs lines, resulting in about 610km of rail track. Services, however, do not extend to the Atlantic Seaboard, Blaauwberg and northern parts of the Northern Suburbs areas because of the lack of rail networks (Figure 1-2). Some of the railway stations,

through the TravelSmart program, have been fitted with park-and-ride-facilities to encourage car users to park their vehicles and use the train as their main mode of transport (The Sustainable Transport Unit 2012).

Fare structure for Metrorail train service is distance based, with discounts offered when purchased weekly or monthly or in bulk (Table 1-2). Commuters travelling on first-class are generally low across the metropolitan. They result in about 19% of ticket sales. This percentage was however observed to be higher on the Southern Suburbs line, with about 35% of commuters travelling on first class (Royal Haskoning DHV 2014).

MyCiTi Bus

MyCiTi bus, a bus rapid transit (BRT) system in the city provides transportation to passengers with dedicated lanes on trunk routes. The services started rolling out in 2010 with routes from the city center to Cape Town stadium, airport and temporary routes around the central city. Coverage has since been increased to other parts of the city including Table View, Blaauberg, Parklands, Salt River, Oranjezicht, Tamboerkloof, Sea Point, Camps Bay, Hout Bay, Atlantis, Dunoon, Khayelitsha and Mitchells Plain as of 2015 (Figure 1-2).

Services provided by MyCiTi bus services are all scheduled, with operations starting from just before 04.30 to just after 23:00 depending on the route. Fares are also distance based with payments made through a card system. Passengers have the option of buying the MyConnect card or a one-time ticket for their journey. Passengers who buy the MyConnect card can also load the MyCiTi mover travel package that offer discount travels.

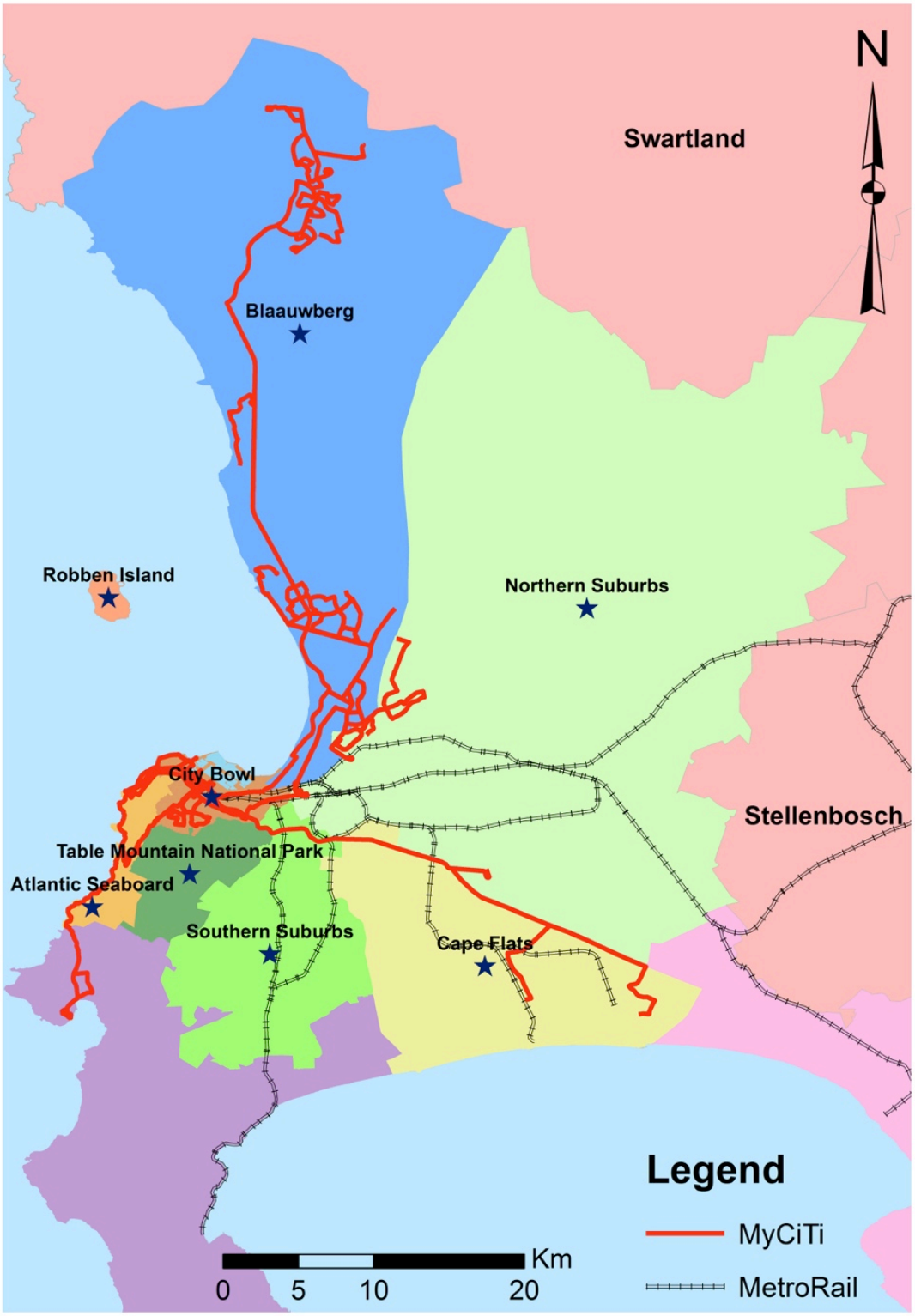


Figure 1-2: MyCiTi Bus and MetroRail Network

Table 1-2: Summary of public transport service features

Service Feature	Mini-Bus Taxi	Metered Taxi	Golden Arrow Bus Services	MetroRail	MyCiTi Bus
Dedicated travel way	No	No	No	Yes	Partial (on trunk routes)
Scheduling	No	No (on call)	Yes	Yes	Yes
Fare (method of payment)	Cash	Cash	Paper Ticket	Paper Ticket	MyCiTi card
Fare Calculation	-	Kilometre based		Distance travelled	Kilometre based
Ticket Validation	-	-	By conductor	By conductor	Electronic
Ability to break trip shortly with single fare	No	Yes		Yes	Yes
Universal accessibility	No	Yes	No	Yes	Yes

1.4.3. Trends in Mode use

Vehicle ownership has been observed to be on the increase in Cape Town, growing at an annual rate of about 3 to 4% (Adjei, Behrens *et al.* 2014). The modal share of private vehicles for daily passenger trips entering the central business district (CBD) has however been observed to be on the decline from 2001 to 2012 (Figure 1-3). Adjei, Behrens *et al.* (2014) suggested the observed decline to be as a result of the development of other attraction points in the city such as the Tygervalley business district. As of 2012, a private vehicle modal share of 58% was reported as against a public transport modal share of 42%. The city-wide modal share for private vehicles to work as revealed by the City of Cape Town's household travel diary survey was however lower than that entering the CBD. A modal share of about 50% for private vehicles was recorded (Figure 1-4). Private vehicle modal share for work trips was however observed to be on the increase over the years, even though marginal. Modal share for train was observed to be on the decline over the years, with a share of about 12% recorded as of 2013. Another mode with a marginal decrease over the years was the bus, recording a share of about 13% as of 2013. Minibus-taxi use was however, on the increase, recording a modal share of about 25% in 2013.

Most private vehicle users were reportedly high-income earners, reporting a split of 91% for private vehicles and only 9% for public transport. Low-income earners on the other hand were reported to be high patronisers of public transport with a modal share of 75% (Transport for Cape Town 2013).

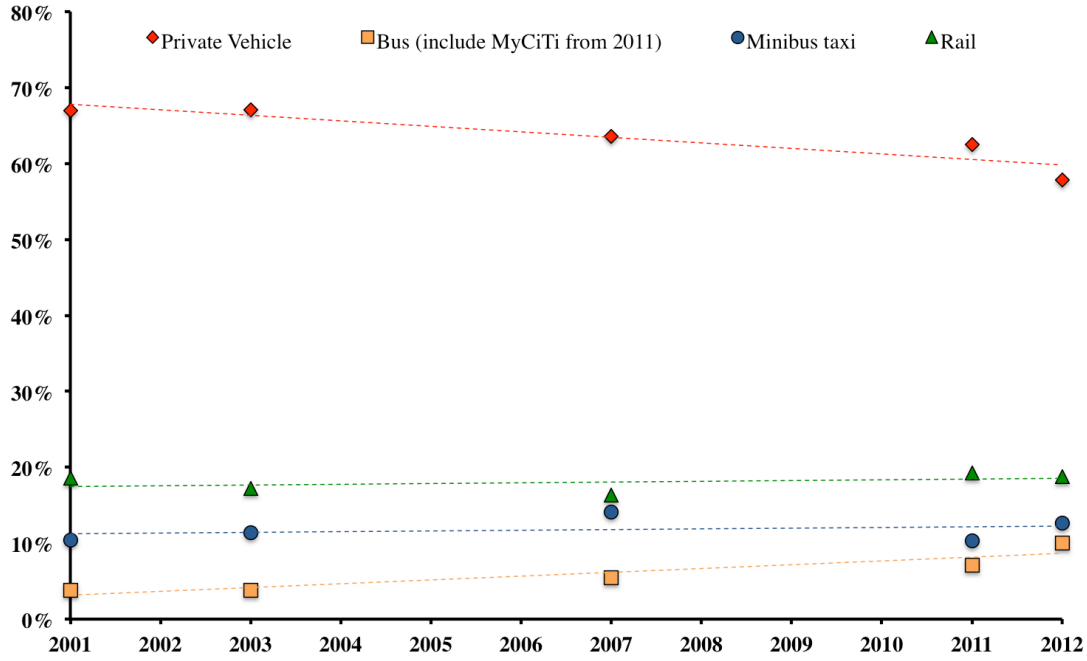


Figure 1-3: Motorised mode share of daily passenger trips entering the Cape Town central business district [data from Transport for Cape Town (2013)]

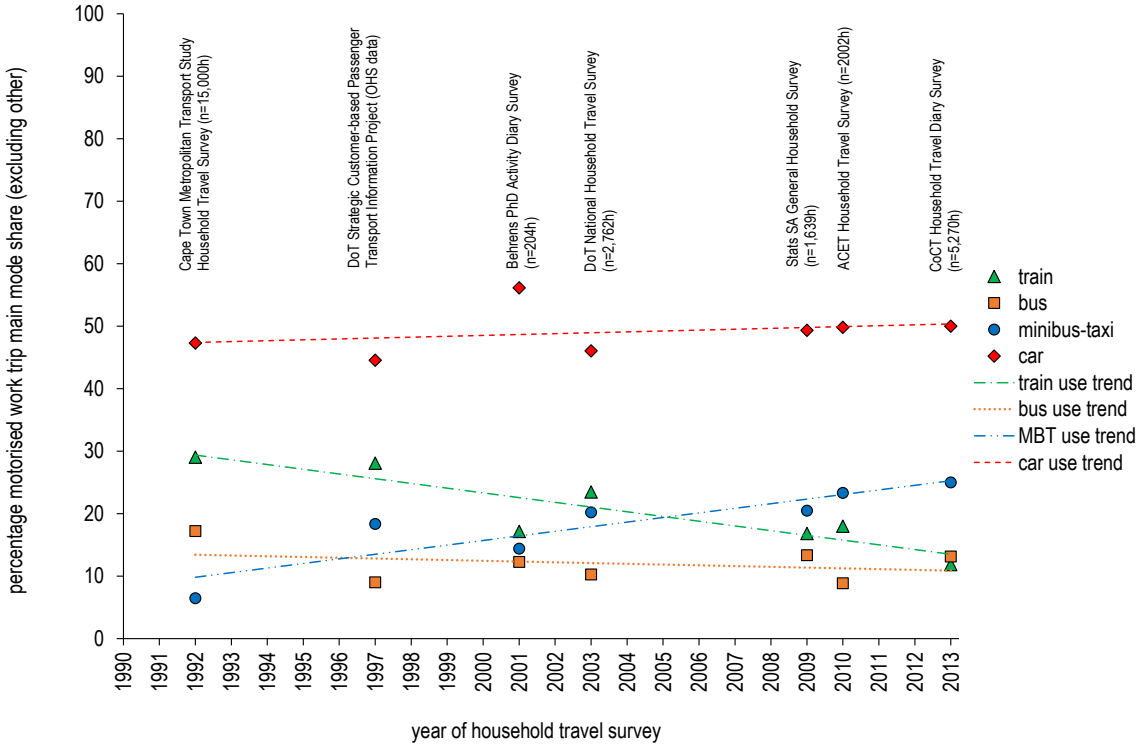


Figure 1-4: City-wide motorised mode use share for work trips (Adjei, Behrens *et al.* 2014)

1.5. Thesis Structure

This thesis is separated into five chapters.

Chapter 1 introduces the thesis by providing background to the research. It identifies the need for travel demand management measures to be grounded in theory for improved successes at changing mode use behaviour. The quest to better understand the dynamism of travel behaviour led to the formulation of two research objectives, upon which the study was based. The first objective was to test the proposition that commuters in Cape Town engage for long periods of time in non-deliberative habitual mode choice behaviour while exhibiting considerable levels of intra-personal variability. The second objective was then to gain empirical insight into the dynamics of habit breaking events. Thus, to understand the process of mode use changes by commuters when they are triggered by the occurrence of a life course event. The chapter then gives a brief description of the study area with emphasis on the public transportation system in the city of Cape Town.

Chapter 2 reports on the behavioural and behavioural change theories reviewed. It sets the tone for the study by providing and understanding of some behavioural and behavioural change theories relevant to travel choices. Four questions were identified, which formed the basis upon which the theories were classified. First, theories that were argued to answer the question of how behavioural choices are made are presented. This is followed by theories that are more geared towards uncovering the factors that affect choice making. Theories that showed when behavioural changes occur are then discussed with theories showing how decision-makers respond to behaviour change interventions following suit. Some applications of these theories to travel behaviour change experiments were then investigated. A synthesis of the behavioural and behavioural change theories is then reported on.

Chapter 3 then investigate on the first objective of the study, thus determining the validity of the proposition that commuters in Cape Town engage for long periods of time in non-deliberative habitual mode choice behaviour while exhibiting considerable levels of intra-personal variability. It investigates the effect of life course events on mode use choices through the use of a qualitative mobility biography. It starts by reviewing literature about the dynamics of travel patterns. This led to the formation of research questions upon which the study was based. A review of different methods for the collection of longitudinal data is then carried out and how data was collected, revealing retrospective survey as the most viable method for this study. Problems associated with retrospective surveys are then discussed along with solutions to some of these problems, including the use of event

history calendars. The results from the study are then presented. First were the results about short-term dynamics, revealing variabilities in certain attributes of mode use choice. Insights into long-term travel dynamics and how they are affected by life course events are then presented. The chapter concludes by examining the proposition with the results from the mobility biography study.

Chapter 4 reports on the empirical insights gained on the process of habit breaking when commuters are experiencing life course events. It starts by presenting the effect of habit on mode use choice and how life course events influence mode choice, exposing the lack of literature on the process through which an individual goes through in making the change. This led to the formulation of research questions to serve as a guide for the study. This study answers a more open question as to understanding the dynamics of habit breaking around life course events, unlike in chapter 3 where a specific proposition was tested. The chapter then present a discussion of the survey tools employed in the study, which included the formulation of deliberation calendar. Analyses about mode use changes among respondents, interconnectivity of life course events, when respondents start to deliberate on change and look for information are then presented. The chapter concludes by discussing the process of breaking mode use choice habits, the significance of life course events being interconnected and attitudinal changes among respondents after using a mode of transport.

Chapter 5 syntheses the whole study, reporting on some implications of the study for the formulation of travel demand management strategies and its implementation in Cape Town. The chapter also reflect on the work done against key research questions and how the results help in improving TDM design and implementation in Cape Town. The contribution of the thesis is then laid out with limitations of the research. Some recommendations for future studies are then made.

Chapter 2. Travel Behaviour Theories and Patterns

2.1. Introduction

Travel demand management (TDM) measures are emerging as central to strategies aimed at reducing carbon emissions, and as an alternative to road capacity increase in the management of congestion. TDM measures aim at changing travel behaviours in order to affect travel demand. They mainly aim at reducing single occupancy car ridership, and to influence shifts towards non-motorised and public travel mode use or distribute demand in space and/or time. These include but are not limited to measures such as: land use planning, provision of infrastructure, information, incentives, car-pooling, road pricing *etc* (Litman 2003; May, Jopson *et al.* 2003). Some of these measures are more coercive than others. Less coercive measures are more likely to be accepted by commuters, even though they are less effective compared to more coercive measures (Loukopoulos 2007). Less coercive measures usually require voluntary behaviour change from commuters. Behaviour change has proven, in most instances, to be difficult to achieve when voluntary behaviour change have been employed. This may be due to the fact that change in itself is considered to be difficult. For individuals to make changes to their travel choices there is the need for them to be motivated into doing so. The understanding of how and why commuters make travel choices and when such behaviours are changed may be important to ensure a successful formulation and implementation of TDM measures to this effect.

Theories of human behaviour offer a starting point to uncover the psychological aspects of travel decision-making, and therefore providing a set of tools to understand and influence travel behaviour. Several theories have been developed in attempts to explain what induces consumers into making choices, how these choices are made and when changes occur. Some of these theories approach behaviour as a function of internal factors prevalent to the individual, such as values, attitudes, personal norms, *etc.* while others see behaviour as a product of external factors such as incentives, societal norms, institutional constraints, *etc* (Jackson 2005; Egmond and Bruel 2007). A further theoretical perspective as advanced by Stern (2000), argues that behaviour is function of both internal and external factors, and that to get a better understanding of the complexities of human behaviour, one needs to acknowledge the influence of both the individual and his or her environment.

This chapter identifies and reviews selected behaviour and behaviour change theories relevant to travel choices that take into consideration a variety of internal and external factors. Four different behavioural and behavioural change questions to which the theories seek to answer are identified: how are choices made when a decision-maker is confronted with a set of behavioural alternatives?; what factors affect choice-making?; when does behavioural change occur?; and how do decision-makers

respond to behaviour change interventions? Darnton (2008) argued behavioural theories and behavioural change theories may have different roles at different stages in travel behaviour change interventions. A distinction between these theories is therefore important in emphasising their different use. In line with this, the theories have been categorised according to the major question they seek to answer even though some of these theories have the ability of answering more than one of these questions (Table 2-1). The first two questions are geared toward explaining travel behaviour and how choices are made, with the last two explaining change in travel behaviour.

Table 2-1: Categorisation of behaviour and behaviour change theories

		Category of theory			
		How are behavioural choices made?	What factors affect choice-making?	When does behavioural change occur?	How do decision-makers respond to behaviour change interventions?
Rational choice theory (including bounded rationality and deficit model)	*(Becker 1976, Simon 1957)*	X			
Prospect theory	*(Kahneman & Tversky 1979)*	X			
Habit formation theory	*(Gärling, Fujii and Boe 2001)*	X		X	
Theory of planned behaviour (including theory of reasoned action)	*(Fishbein & Ajzen 1975, Ajzen 1991)*		X		
Theory of interpersonal behaviour	*(Triandis 1977)*	X	X		
Norm activation theory	*(Schwartz 1977)*		X		
Cognitive dissonance theory	*(Festinger 1957)*			X	
Stages of change model	*(Prochaska & DiClemente 1986)*			X	
Self-perception theory	*(Bem 1972)*				X
Goal setting theory	*(Locke & Latham 1991)*				X

2.2. Theories Explaining How Behaviour Choices are Made

These theories explain the process an individual goes through in making a choice. It looks at whether the deliberations on alternatives are done every time an individual is faced with a choice-making problem or not. The two groups of theories in this category include the rational choice and habit formation theories.

2.2.1. Rational Choice Theories

Rational choice theory (RCT) (also known as *utility maximisation* or *expectancy-value* theories), can be said to be the baseline for the discussion of all behavioural theories (Jackson 2005). RCT proposes that consumers seek to maximise their utility by calculating the costs and benefits of alternatives available to them (Simon 1955; Becker 1976; Scott 2000; Glimcher, Dorris *et al.* 2005). RCTs are purely calculative, neglecting any form of emotions or affections and can only explain what people do and not why they do them (Heath 1976:64). They have their roots in microeconomic theory. The term 'rationality' has been used in two senses by authors over the years (Yang and Lester 2008; Bateson 2010). The first is concerned with the process through which an outcome is attained. This is a much broader use of the term. The second – which is a narrower use of the term – is mainly concerned with the outcome and not by the effort made in arriving at a decision. An outcome is considered rational if it maximises utility to the individual. RCT uses the latter definition of rationality.

RCT relies on a number of assumptions about the individual in order to model behaviour. Among these assumptions include comprehensive knowledge about the various alternatives and attributes available to them and the capability of ranking them according to their utilities and dis-utilities – such a ranking system should be well-organized and stable (Simon 1955). In order to do this ranking, the individual is also assumed to be capable of computing, storing and retrieving this information whenever he or she wants to make a choice (Simon 1955; de Palma 1998). Based on these assumptions, the individual ranks the available alternatives based on their attributes. The alternative that offers the highest utility to the individual is then chosen. It is assumed that these processes of choice-making are always carried out whenever the individual is faced with a decision. Rational choice theories are considered to be individualistic, thus choices made by individuals are not affected by choices made by others and are self-centred.

These underlying assumptions of RCT have been subjected to several criticisms from different authors even though RCT have been the most extensively used theory in travel planning and forecasts over the

years. The most criticised assumptions of RCT include that of comprehensive or global knowledge of all available alternatives, and the cognitive powers of the human brain in computing the various utilities and dis-utilities (Simon 1955; de Palma 1998; Jackson 2005). Winston (1989), for instance, argued it is rarely rational (in the broader sense) to be maximally rational since it requires resources such as time, energy, *etc.* in collecting and processing information. Also criticised is the individualistic assumption and neglect of emotions or affection. It is argued one's society may have influence on his or her decisions even when decisions are made individually (Scott 2000; Jackson 2005). Scott (2000) argued that if decision makers only sought after their personal utility, then there would be no altruistic behaviour (that is, choosing to do something that benefits others more than it benefits oneself). Non-rational elements such as emotions and affection have also been argued to confound rational decisions (Winston 1989; Scott 2000; Jackson 2005), critiquing the assumption that decision making is not affected by emotions or affection in RCT.

In light of these criticisms, changes have been made to the classical rational choice theories in efforts to address some of these limitations. In particular, Simon (1957) developed the principle of 'bounded rationality' in an attempt to address the limitations of RCT in terms of its comprehensive knowledge of alternative and computation powers of the human brain assumptions

2.2.1.1. Bounded Rationality

The classical rational choice theory assumes individuals have the power to compute, store and retrieve information about the various alternatives available. This assumption would mean the collection of all information about the various alternatives available, which may require a lot of resources. The information would then be processed in order to rank the alternatives. This assumption has been one of the most critiqued assumptions of the classical RC theory. Winston (1989) argued being maximally rational requires the dedication of lots of resources such as time, energy, etc. in the collection and processing of information. These resources he argued could have been used in doing other profitable things. It may therefore be irrational to be maximally rational in making choices. Humans have also been argued to lack the computing ability and memory to store such information should it be collected (de Palma 1998). He argued such an assumption was irrational.

In efforts to address this critique of the classical RC theory, Simon (1957) developed the principle of bounded rationality. He argued that the human mind might not have the capacity to formulate and solve even a reasonable approximation of real world problems needed for optimal rationality. In the

principle of bounded rationality, the individual simplifies the process of making a rational decision by making trade-offs to bring the real situation to the computational powers of the human brain. Instead of seeking a globally optimized alternative that requires the collection and processing of all information about various alternatives, the individual seeks an alternative that would be satisfying, thus a replacement of a global maximization goal with a satisficing goal. This means the collection of less information and computation process than the classical rational choice theory. The alternatives in the simplified model are then ranked with the highest utility alternative chosen. The individual is therefore, said to be rational with respect to the simplified model.

2.2.1.2. Prospect Theory

Kahneman and Tversky (1979) criticised expected utility theories for not being helpful when it comes to making decisions in which the outcome is uncertain (e.g. a route choice decision in the context of volatile congestion and uncertain travel times). They therefore advanced prospect theory (PT) as an alternative model for explaining how decisions are made which involve some degree of uncertainty.

In PT, people try to avoid outcomes that they are uncertain about when making decisions. They do this by giving more weight to alternatives with greater certainty of outcome than others that are merely probable. Kahneman and Tversky showed that when gains and losses associated with choice alternatives are made more explicit, loss aversion is triggered, as the emotion of loss is stronger than the emotion of gain.

The theory comprises of two phases – the editing and evaluation phases – in the decision-making process. In the editing phase – involving the coding, combination, segregation, cancelation, simplification, and detection of dominance stages (Kahneman and Tversky 1979; Experimental Economics Centre 2006) – the choice alternatives are organized and reformulated to simplify them for evaluation. The perceived outcomes are coded either as gains or losses, which are later simplified by combining similar outcomes. Riskless components are then segregated from risky ones. Components shared by the various alternatives are cancelled out and ones distinguishing the alternatives focused on. The simplification stage includes the discarding of extremely unlikely outcomes. The outcomes are then scanned for dominant alternatives. Alternatives that do not show up prominently during the scanning process are then rejected. The dominant alternatives are then evaluated by applying decision weights and subjective values. The alternative with the highest value is then chosen.

The prospect theory was "developed for simple prospects with monetary outcomes and stated probabilities" (Kahneman and Tversky 1979 p:274). They have however been extended to choice making between prospects with certain outcomes (Tversky and Kahneman 1991) and also unlimited outcomes of uncertainties (Tversky and Kahneman 1992). The use of PT in travel behaviour studies have concentrated more on travel and arrival times than modal choice, because of the high degree of uncertainty in the former (van Wee 2010).

2.2.2. Habit Formation Theory

Rational choice theories continue to be the dominantly used theory in transportation planning and forecasting. Habit formation theories are however gaining recognition in the modelling of travel behaviour choices as such choices have been argued to be habitual. Even though the phenomenon of habit or automatic behaviour may be fairly new in the transportation field, it has long been established in various fields, including biology and social psychology (McDougall 1908). James (1890) argued the existence of habit can be found by looking at the fundamental properties of matter, the laws governing nature. He argued through several examples of how different elements enter into a cycle of habit through interactions among themselves (see James 1890, page 105).

Psychologists define habit as learned sequences of acts, aimed at obtaining certain goals or end states, that become automatic responses to specific situations (James 1890; Watson 1914). The specification of goal orientation distinguishes habit from other forms of automatic behaviour such as reflex, which may be characterised as 'mindless'. Gärling, Gillholm *et al.* (1998) also differentiated between habitual behaviour and impulsive or reflexive behaviour. Habitual behaviour was argued to apply when no intention is formed and impulsive or reflexive behaviour applies when intention is formed late relative to enactment of the behaviour without time for much deliberation. Langer (1989) argues a history of successful repetition of relevant acts is what distinguishes habit from mindless behaviour.

Progression from deliberate to script-based choice

Gärling, Fujii *et al.* (2001) proposed the notion of script-based choice as a means to describe the process of migration from rational deliberation to automatic repetition of behaviour. In their conception, the individual engages in rational deliberation to locate a preference among a set of alternatives when faced with a choice decision for the first time. If a positive outcome results from the enactment of the preference-based choice, this set of steps (i.e. deliberation-to-choice-to-experience of the positive outcome) become codified as a script which the individual can retrieve in future when

confronted with the same decision-situation (Figure 2-1). In this way, decisions become script-based over time.

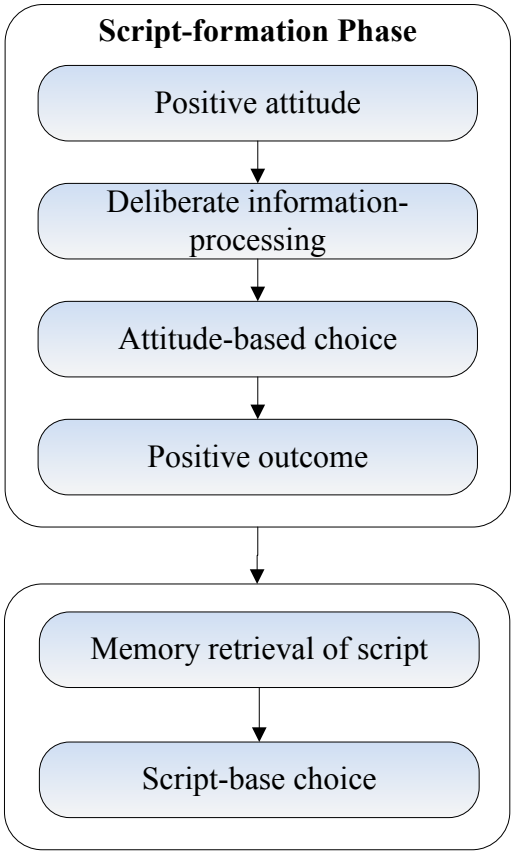


Figure 2-1: Model of script-based choice development (Gärling, Fujii *et al.* 2001)

Under the same conditions, the same choice is repeated, forming habit. It has been argued that the more repetitious an activity becomes, the stronger the formation of habit and the less deliberation on choice making (Dahlstrand and Biel 1997; Bamberg, Ajzen *et al.* 2003; Garvill, Marell *et al.* 2003). Several degrees of habitual behaviour may thus be observed.

Some authors (e.g. Hanson and Huff 1988) have described the repetitious choice made by commuters as simply a repetition of deliberation which yield the same result in each case and not that the choice has become habitual. Gärling and Axhausen (2003) argued that, if the situation remains unchanged, repeating choice after first time deliberation may be more rational or more appropriate than the maximal rationality of classical rational choice theories. Thus habit may be considered rational if the condition under which it was formed is the same as during the time a decision is made. They however argued it may not be considered rational (in the narrow sense) if the same choice is made even when

the situation changes, at which time the choice may be considered as strongly habitual and cannot be changed easily by small changes in circumstances.

Modifying habitual travel behaviour

As habitual choice behaviour requires little or no deliberation over various alternatives available (Verplanken, Aarts *et al.* 1997; Gärling and Axhausen 2003; Garvill, Marell *et al.* 2003), little or no information is sort after in decision-making. Inducing a deliberate choice-making process has been seen to be a step towards breaking habit (Garvill, Marell *et al.* 2003). Measures employed in attempts at inducing deliberation that may lead to travel behaviour change include the provision of information about alternatives, creation of awareness, provision of incentives and disruptions in car use (Fujii, Gärling *et al.* 2001; Fujii and Kitamura 2003; Gärling and Fujii 2006). Not all have been effective in all times in changing habitual behaviour. Dahlstrand and Beil (1997) argued the provision of information about alternatives only may not be effective in changing people with strong habits compared to other measures such as disruption of traffic flow as these people usually do not consider other information when making choices. This is because there is little or no deliberation when making travel choices. There may therefore be the need for habitual commuters to be pushed in order to deliberate over their travel choice. It is therefore imperative to know the degree of habit when formulating polices aimed at changing habitual choices.

Habit formation theories have received increasing attention in travel behaviour studies over the past decade. Some authors argue habits developed in past behaviour are a better predictor of behaviour than attitudes (Triandis 1977; Ouellette and Wood 1998).

2.3. Theories Explaining What Factors Affect Choice-making

While the aforementioned theories show the process through which an individual goes in making travel choice decisions, the next set of theories go beyond this by looking at factors contributing to the decision-making. They look at the individual beliefs, societal beliefs and or norms, control beliefs, emotions, *etc.* that come into play when an individual deliberates on alternatives. This category of theories includes the theory of reasoned action and planned behaviour, theory of interpersonal behaviour and norm activation theory.

2.3.1. Theories of Reasoned Action and Planned Behaviour

Fishbein and Ajzen (1975) argued that many earlier researchers assumed attitude as a predictor of behaviour even though they had repeatedly failed to show a strong relation between them. They also revealed the ambiguous use of "behaviour" in several studies and instead of measuring the relationship between attitude and behaviour; they had actually been measuring the relationship between attitude and intention. The theory of reasoned action (TRA) was therefore developed to predict behaviour with intentions conceptualised as the immediate antecedent of behaviour. Intentions indicated the degree of effort an individual plans to expend for the enactment of behaviour. The bigger the effort an individual plans to put in, the higher the probability of observing the behaviour. TRA was developed to predict and explain behaviours over which people have complete volitional control (Ajzen 1985; Ajzen 1991). TRA proposes intention as the immediate antecedent of a person's behaviour. Intention is then determined by a person's attitude toward the behaviour and subjective norms. The attitude toward the behaviour, considered as of a personal nature represents the salient beliefs about the consequences and evaluation of the behaviour in question while subjective norms refer to the beliefs a person holds about what relevant referents think of enacting the behaviour and the motivation to comply reflecting social influence (Fishbein and Ajzen 1975; Ajzen 1985). Personal attitudes toward behaviour are in turn influenced by behavioural beliefs while subjective norms are influenced by normative beliefs. These beliefs are influenced by environmental and social factors such as culture, gender, economic status *etc*. The theory assumes the individual evaluates his intentions by giving weights to the two determinants of his intentions. Intentions with positive outcomes are usually enacted. The weighting of the two determinants – attitude toward behaviour and subjective norms – may depend on the intention under investigation and are subjective (Ajzen 1985). The weights given to these determinants by one person may thus be different to weights given to them by another person, even of the same society.

TRA was observed to be less accurate in predicting behaviours that are influenced by factors not completely under the control of the person. TRA was thus limited in its applications as most behaviour was observed to be influenced to some degree by factors not under personal control. The theory of planned behaviour (TPB) was developed by Ajzen (1985) as an extension to TRA to predict behaviour of such kind. Ajzen pointed out the transition from behavioural intentions to observed behaviour as the major limitation of TRA. Intentions are likely to be enacted into behaviour the stronger they are and shorter the time interval between them (Ajzen 1985; Ajzen 1991). He also argued behavioural intentions did not really predict observed behaviour but rather attempted behaviour and if it fails to

predict attempted behaviour, then it was possibly changed before it was enacted. However if it was able to predict attempted behaviour but not actual behaviour, then it could be that it was prevented by factors beyond the control of the person. These factors such as time, skills, opportunity *etc.* represent the person's actual control of behaviour (Ajzen 1991). A third determinant of intention was introduced as perceived behavioural control. Perceived behavioural control (PBC) refers to how people perceive control of their behaviour – thus how easy or difficult it is for them to perform behaviour. The introduction of the PBC as a determinant of intention signalling an extension to TRA was argued to help in predicting behavioural intentions not under the complete volitional control of people but still did predict only attempted behaviour and not actual behaviour. As a latest addition to what seems to be a continuous improvement of the TPB to predict actual behaviour, actual behavioural control has also been included in addition to perceived behavioural control (Ajzen and Fishbein 2005). Figure 2-2 represents the evolution of TRA as developed in 1975 to its current state as TPB in 2005.

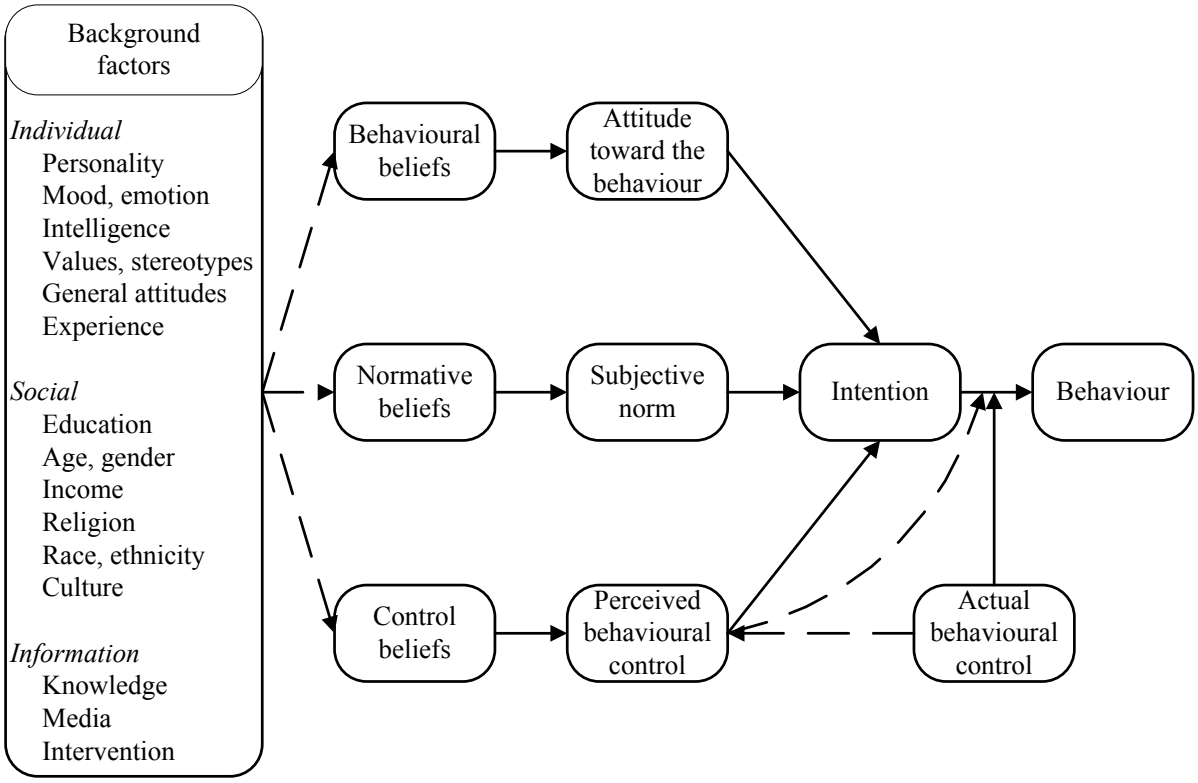


Figure 2-2: Theories of reasoned action and planned behaviour (Ajzen and Fishbein 2005)

Ajzen argued behavioural intentions would have stronger influence on actual behaviour when actual behavioural control is high. Thus behavioural intentions stand higher chances of been actualised when an individual has higher control of the behaviour. Perceived behavioural control, can however serve as a proxy for actual behavioural control when predicting behaviour. He reported on the absence of

several relations from the diagram in order to keep it simple. One such relationship is a feedback loop from behaviour to intention. The enactment of behaviour may influence future intentions by providing new information about the said behaviour – this he argued may be captured in 'experience', one of the background factors. New information may also alter one's beliefs about the behaviour. The individual is also not always thought of as evaluating all information to form attitudes, norms and perceived control whenever they are to engage in behaviour. These beliefs, once formed may be called upon when behaviour is to be enacted.

TPB has been applied in various travel behaviour studies since its inception – ranging from public transport use (e.g. Bamberg and Schmidt 1999) to road crossing (e.g. Evans and Norman 1998). It has been used in explaining and measuring the influence of attitudes and beliefs on behaviour. Despite the extensive use of TPB in predicting behaviour (see Heath and Gifford 2002; Anable 2005; Bamberg 2006; Beale and Bonsall 2007; Taniguchi and Fujii 2007; Dill and Mohr 2010), it has also seen some criticisms over the years with some authors criticising the theory for its inadequacy in explaining social behaviour (Ajzen 2011). One of the main criticisms of TPB has been its emphasis on cognitive deliberation whenever a person is faced with a choice making problem and neglect of affection and habit (Egmond and Bruel 2007). Ajzen (2011) rejected this criticism by stating that even though TPB is much concerned with the information processing aspects of people, it does not assume a totally rational person. He argued affection and emotion can indirectly affect intentions by influencing behavioural, normative and/or control beliefs. He also argued attitudes, subjective norms, and perceptions of control as well as intention implicitly guide routine behaviours – which can be considered as habit – without much cognitive efforts.

2.3.2. Theory of Interpersonal Behaviour

Like TPB, the theory of interpersonal behaviour (TIB) also defines intention as one of the influential factors of behaviour. Unlike the TPB however, Triandis (1977) explicitly took into consideration habit when explaining or predicting behaviour. Triandis (1977) proposed habit, intention and facilitating conditions as the three determinants of behaviour in a ranking order (Figure 2-3). Habit and intentions interact with each other in the presence or absence of facilitating conditions to either enable or impede the enactment of behaviour. He argued the stronger the habit, the less the effect of intentions on behaviour, and vice versa.

Intentions were argued to be formed by the interaction between attitudes, social factors and affection. As with Fishbein and Ajzen's TRA and TPB, attitude is preceded by belief. Triandis, however added the evaluation of outcomes (representing the deliberative aspect of humans) as one of the influencing factors to the formation of attitudes. Social factors (which may be termed as subjective norm in the case of TRA and TPB) are determined by norms, roles and self-concept (representing the extent to which revered individuals and society can affect behaviour). Unlike TRA and TPB, TIB consider affection as a third determinant of intentions. This represents the extent to which the person enjoys or dislikes the behaviour.

Habit is considered as the most influential factor on behaviour (Triandis 1977). It is defined as "situation-behaviour sequences that are or have become automatic, so that they occur without self-instruction." (Triandis 1980 as cited in; Bamberg and Schmidt 2003). Triandis argued the more the same behaviour is repeated, the higher the influence of habit over that particular behaviour and the less influential intentions become. Behavioural intentions may thus be absent in highly habitual behaviours. The frequency of past behaviour is used as a determinant of habit in TIB.

Despite the greater predictive power of the TIB over TPB as demonstrated by Bamberg and Schmidt (2003), TIB has received relatively less attention as compared to the TPB (Darnton 2008) in the travel behaviour field. Bamberg and Schmidt (2003) suggest that TIB may gain increased recognition in this field due to the insufficiencies of TPB in explaining social behaviours and the increasing recognition of habit as a major factor in predicting travel behaviours.

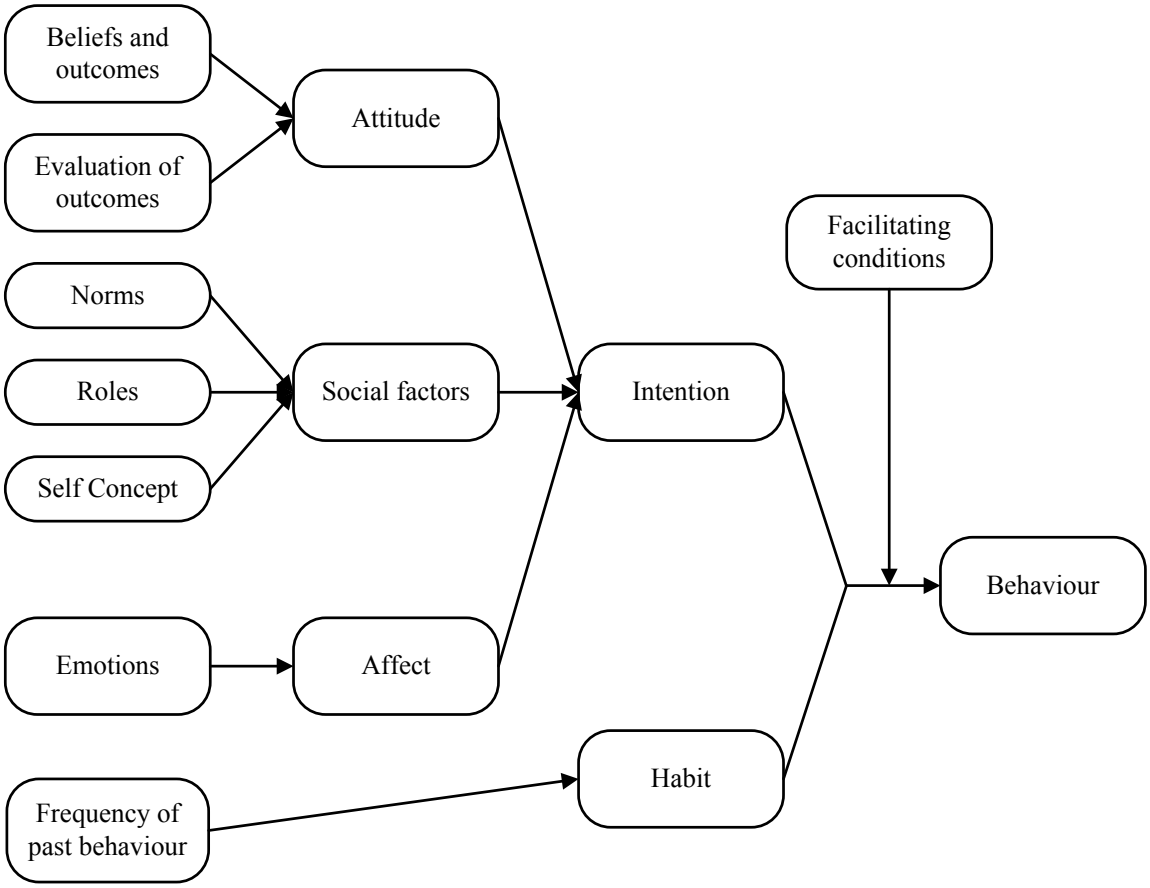


Figure 2-3: Theory of interpersonal behaviour (Reproduced from Jackson 2005)

2.3.3. Norm Activation Theory

The norm activation theory (NAT) developed by Schwartz (1977) proposes personal norms as the determinant of pro-social behaviour (Figure 2-4). Different from TPB and TIB, the norm activation theory does not purport to be a general theory of human behaviour but rather as a theory to explain altruistic behaviour (Darnton 2008; Wall, Devine-Wright *et al.* 2008). Behaviour is said to be altruistic when the intentions for the behaviour are to the benefit of others. The theory is purported to be based on three propositions: an obligation proposition, an activation proposition and a defence proposition (Schwartz 1977). Individuals are to be morally obliged in order to taken actions that are within their control in helping alleviate the needs of others. These obligations are usually activated by personal norms and values. The obligation to act may however, be neutralised when the relevance of the behaviour is questioned. Altruistic behaviours should therefore be within the behavioural control of the individuals and relevant to him/her. Personal norms – which may oblige the individual – are said to be formed through the adaptation of social norms and only activated when the person becomes aware of

the consequences of his or her behaviour and take responsibilities for them (Klöckner and Matthies 2004; Wall, Devine-Wright *et al.* 2008).

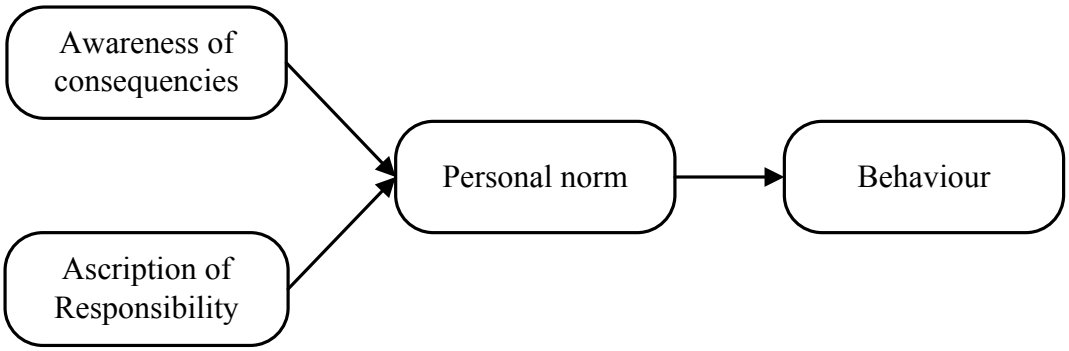


Figure 2-4: Norm activation model (adapted from Jackson 2005)

Schwartz and Howard (1981 as cited in; Klöckner and Matthies 2004) proposed four stages through which normative decisions are made: attention, motivation, evaluation and denial stages. At the attention stage (or as Schwartz 1977 calls it: the activation step), the individual become aware of the state of need for something to be done and the consequences of their actions. The individual should also recognise the need for an action to relieve the problem that should be under their control. If such actions are not under the control of the individual, such behaviour may not be enacted. This is similar to the theory of planned behaviour's perceived behavioural control component. At the motivation stage, the said behaviour is vetted against one's personal and social norms. The person is only motivated to act if the behaviour in question is consistent with his/her personal norms. This is followed by a cost and benefit evaluation of the available alternatives. The variable for evaluation may be monetary or non-monetary. Some non-monetary variables include the feeling of satisfaction or guilt, comfort, safety, time, *etc.* After evaluation, the alternative with the highest utility is chosen. If no clear decision is made, the fourth stage is executed, at which stage the moral component of the decision-making process is either altered or entirely removed. Some of the components altered may include the problem itself, the ascription of responsibility for the problem and personal control. The process is repeated until a decision to act is made or to a point where the individual no longer feels morally oblige to act.

There have been mixed results in the application of NAT in travel behaviour studies with some authors finding relation between norms and car use while others have not. For instance, Bamberg and Schmidt (2003) found no significant relations between moral beliefs and car use, while Wall *et al* (2007) found evidence of personal norms informing car use reduction goals.

2.4. Theories Explaining When Travel Behaviour Change Occur

Darnton (2008) in his review of behaviour change models pointed out how many reviewers have neglected theories of behavioural change and have only concentrated on behavioural models. He attributed this to the clear overlap between behavioural and behavioural change theories. Darnton, however, argued making a distinction between behavioural and behavioural change theories and models "emphasises the different uses of the two types of evidence when planning behaviour change interventions" (Darnton 2008 p. 39).

While most behavioural theories suggest behaviour as a one-off action, theories of behavioural change either implicitly or explicitly do include a temporal dimension to behaviour – thus regarding routine behaviour as habitual (Darnton 2008). Unlike defining habit as an automatic behaviour without self-instruction, Lewin (1951) defined habit as "resistance to change" which is considered as a sign of resilience which a person adapts to keep behaviour constant. He proposed a change theory where habitual behaviours are unfrozen from undesired behaviour, changed to desired ones and refrozen. Lewin demonstrated the temporal nature of this process and importance of maintaining external conditions that aid in behavioural change; at least until the desired behaviour is refrozen.

Behavioural change theories to be considered include the theory of cognitive dissonance and stages of change model. The goal setting theory will then be looked at, which shows how well behavioural change can be obtained.

2.4.1. Cognitive Dissonance Theory

Cognitive dissonance theory (CDT) is centred on an individual's drive for consistency within oneself as a motivator for behavioural change. CDT proposes that a person will try attaining consonance between two cognitions if they are in conflict with each other. Festinger (1957) conceptualised an individual's behaviour as a function of the knowledge about oneself – termed as behavioural cognitive elements (beliefs, values, attitudes) – and about ones surroundings – termed as environmental cognitive elements (Figure 2-5). He proposed a dissonance between these two cognitive elements would pressurize the individual into making efforts in bringing them back into consonance with each other. This urge for attaining consonance is a function of how a person values these two cognitive elements. The more important a person values the cognitive elements involved, the higher the dissonance between them and the higher the pressure there is in bringing them back into consonance. Dissonance between two cognitions may arise when new information contrary to ones prior beliefs are

made available. Either of the two cognitive elements could be changed in attempts at attaining consonance or reducing dissonance. Changing environmental cognitions are much more difficult as individuals mostly lack control over the environment within which decisions are made. This is not so with behavioural cognitions as individuals usually have much control over them. Behavioural cognitions are thus easier to change.

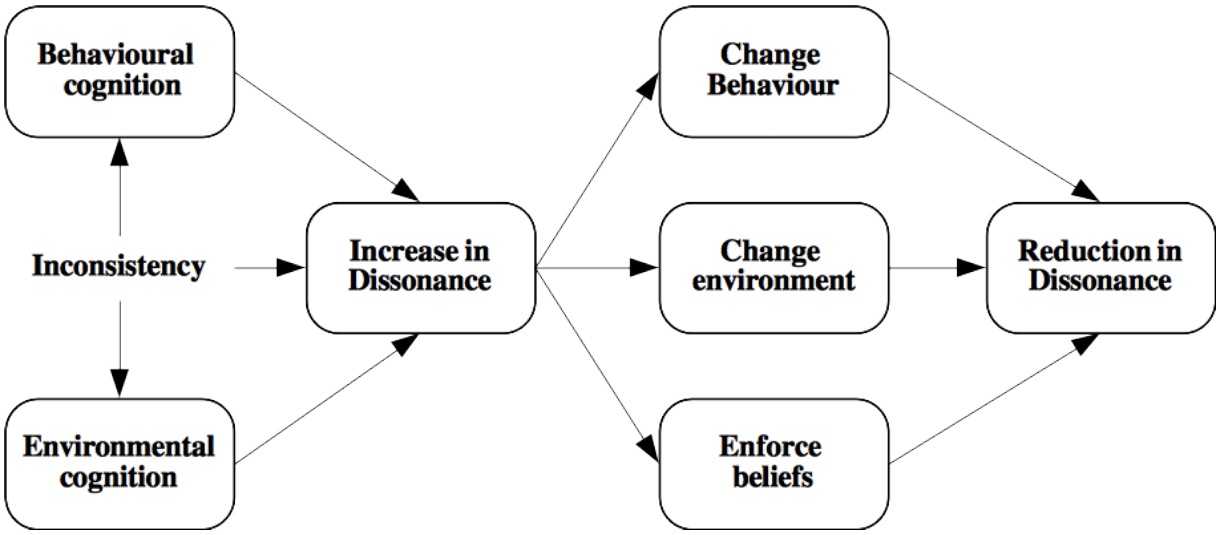


Figure 2-5: Cognitive dissonance theory (adapted from Joy 2016)

In changing behavioural cognition, an individual may either change the behaviour itself or may seek to acquire more information to buttress the behaviour. For example, after becoming aware of the unsustainable nature of regular car use, a habitual car user may reduce or desist from using the car or may seek more contrary information about its benefits to come to peace with using the car. Information that is likely to increase dissonance between the two cognitions is, however, avoided. Festinger pointed out that, even though dissonance introduces discomfort and pressures the individual to strive for consonance; the individual might come to terms with the dissonance persisting between the two cognitive elements. This may be due to the difficulties one may encounter while changing either the behaviour or the knowledge about the behaviour or the environment. Changes might, however, be observed if the individual becomes capable of changing either the behaviour or the environmental cognition. Behavioural control is therefore needed for changes in behaviour to be observed.

While the application of CDT in travel behaviour studies is seldom explicitly acknowledged, it could be argued that it is implicit in studies that use information as a means of changing the attitudes of

decision-makers. In such cases the new information may be dissonant with the decision-makers' cognition, causing behaviour change.

2.4.2. Stages of Change Model

The stages of change model (SCM) – one of the constructs of the trans-theoretical model of behavioural changes developed by Prochaska and DiClemente (1986) to assess a person's prospects of changing behaviour – posits six stages through which behavioural change occur. These are the pre-contemplation, contemplation, preparation, action, maintenance and termination stages (Figure 2-6).

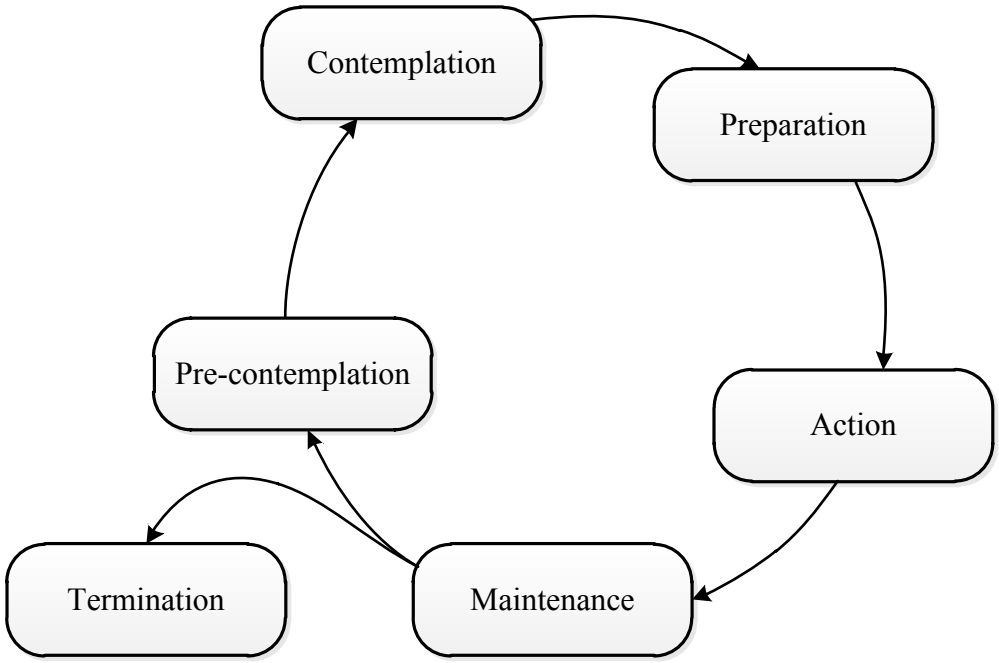


Figure 2-6: Stages of change model (Prochaska and DiClemente 1986)

At the pre-contemplation stage, decision-makers have no intention of changing behaviour, as they are not aware of the problems associated with their behaviour or are in a state of denial. The consequence of their behaviour is either denied or minimized. Through the provision of information and social pressures, decision-makers may become aware of the consequences of behaviour (Frasier, Slatt *et al.* 2001). Decision-makers then start contemplating on behavioural changes, at which stage the benefits and costs of various alternatives are considered. After the decision-maker becomes aware of the costs and benefits of change, they prepare for behavioural change by forming action plans. At the preparation stage, some behavioural changes may be observed (Frasier, Slatt *et al.* 2001; Darnton 2008). The action plan for behavioural change is then carried out at the next stage where behavioural

modifications are overtly observed. The next stage – maintenance – may be considered as a very important stage in the design of behavioural interventions, especially when dealing with habitual behaviours. At this stage, the decision-maker tries to avoid a relapse to past behaviour. Maintaining the context within which such behavioural change occurred is therefore important for the new behaviour to become habitual. The new behaviour then alters personal norms and the temptation to relapse to past-undesired behaviour becomes minimal. At the termination stage, the new behaviour becomes normative, removing any chances of relapse.

Behaviour changes are suggested to be a process that may involve relapses to earlier stages, even in the case of a successful change. Individuals making successful behaviour changes, however, do not relent or stay in earlier stages they have relapsed to, but rather strive for progress to the maintenance stage, where habits may be formed.

SCM has been used in formulating behavioural interventions. Gatersleben and Appleton (2007), showed that commuters become more positive towards cycling as they progress from the pre-contemplation stage to the action stage. They therefore argued for different strategies at the different stages of behaviour change. This was confirmed by Nkurunziza *et al* (2012), who argued segmenting decision makers according to the different stages can aid in defining more targeted and efficient travel behaviour interventions (in this case, cycling in Dar es Salaam).

2.5. Theories Explaining How Decision-makers Respond to Behaviour Change Interventions

Reactions to TDM measures are usually expected when they are applied. Reactions are however, not expected to be uniform across all individuals, as they have been argued to respond differently to behavioural change interventions. These set of theories seek to explain how these differences arise. They include the self-perception and goal setting theories.

2.5.1. Self-Perception Theory

Self-perception theory (SPT) was proposed to offer an alternative explanation to the phenomena leading to Festinger's CDT (Bem 1967; Bem 1972). In SPT, an individual discovers or amends his or her attitudes, emotions, and other internal states by observing his or her behaviour and experience. This Bem argued to be similar to how inferences about people's behaviour are done by observing their

overt behaviour and it is more prevalent when personal beliefs towards the behaviour are weak or ambiguous.

Contrary to (CDT), and most other behavioural theories, SPT is counterintuitive as behaviour is assumed to precede attitude (Figure 2-7). In SPT, an individual's attitudes or beliefs towards a particular behaviour may change after enacting the behaviour in question. Jackson (2005) argued that while the assumption of behaviour preceding attitude may not always be valid, SPT can complement Festinger's CDT. Bem (1972) identified experiments involving forced behavioural change as examples of where SPT had greater explanatory power than CDT. In these types of experiments, participants are usually not persuaded by information (the case of CDT) or by other forms of incentives into changing behaviour, but are rather forced into doing so. Behaviours are mostly contrary to one's beliefs. Continual enactment of the behaviour after the change may indicate a change in beliefs towards the behaviour; otherwise the individual is likely to return to the old behaviour.

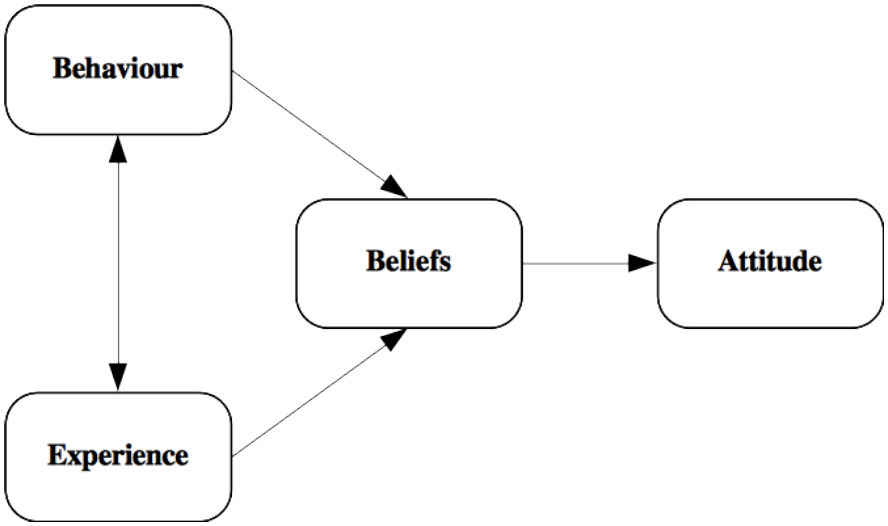


Figure 2-7: Self-perception theory (Author)

Similar to CDT, the explicit use of SPT in travel behaviour studies has been limited. However, it is implicit in interventions where individuals are made to experience certain travel choices aimed at changing their attitude (e.g. the issuance of free public bus tickets (Fujii and Kitamura 2003), or the closure of a freeway, forcing drivers to use public transport (Fujii, Gärling *et al.* 2001; Fujii and Kitamura 2003)).

2.5.2. Goal Setting Theory

The goal setting theory (GST) advanced by Latham and Locke (1991) proposes human behaviour as motivated by conscious purpose which is in turn regulated by the decision-maker's goals. GST focuses on the performance of behaviour – in other words, on why people perform better than others given the same knowledge and ability. GST states that the simplest and most direct motivational explanation of why some people perform better than others is because they have different performance goals (Latham and Locke 1991 p. 213).

Two aspects of goal contents – specificity and difficulty – have been seen to affect performance. Specificity of goals set can range from vague to specific while difficulty can be divided into easy, moderate, difficult or impossible. The difficultness of a goal or how challenging it is, vary from one person to the other, depending on one's ability – thus the same goal may be difficult for one person but not for the other. Generally, people with more specific and challenging goals were seen to have higher performance towards goal attainment than those with either specific but unchallenging, vague but challenging, vague but unchallenging or no goals (Locke, Shaw *et al.* 1981). Vaguely formed goals lead to lower performance but with higher individual satisfaction results – e.g. people with a 'do your best' goal may be satisfied with any achievement compared to people with specific goals. Also more challenging goals are seen to result in better performance than easy ones, even though they are rarely reached. They must however be set within an individual's capacity for easy acceptance of goals.

The progression from goals to performance is facilitated by the presence of two factors – goal mechanisms and moderators (Figure 2-8). Four goal mechanisms were identified, namely; choice, effort, persistence and strategies (Locke and Latham 2002). The choice of goals determines the amount of effort and attention directed toward achieving the goal by an individual. More challenging goals were seen to lead to higher efforts. The choice of goals also affects the strategies employed in achieving it. Individuals were found to rely on habits – thus using their already known skills and knowledge – when faced with a goal they are familiar with. However, new strategies are developed if the task is new to them. Moderators of goal attainment include; commitment, feedback and task complexity.

Commitment to a goal "refers to the degree to which the individual is attached to the goal, considers it significant or important, is determined to reach it, and keeps it in the face of setbacks and obstacles" (Latham and Locke 1991 p. 217). Factors affecting commitment to a goal include the importance of

the goal to the individual and self-efficacy. Self-efficacy refers to the extent to which an individual believes in his/her own abilities in attaining a goal. Self-efficacy is high when the individual is equipped with the necessary skills and tools for the task. Self-efficacy can also be enriched through the use of persuasive communication. Individuals are more likely to stay committed to the performance of a goal if it is within their ability. Importance of a goal to an individual was found to increase when they are encouraged to take part in its formulation. However, assigned goals with reasons were also found to be equally important to individuals. The more people perceive a goal as achievable and important, the higher their commitment to attaining the goal. In short, for a better performance of behaviour or behavioural change, the goal should be specific, challenging, achievable and appropriate.

The provision of feedback – as to how well they are doing – was also found by Locke and Latham (2002) to be instrumental for an individual to stay committed in achieving a set goal. They were argued to work better with setting goals in achieving high performance than they will separately (Latham and Locke 1991).

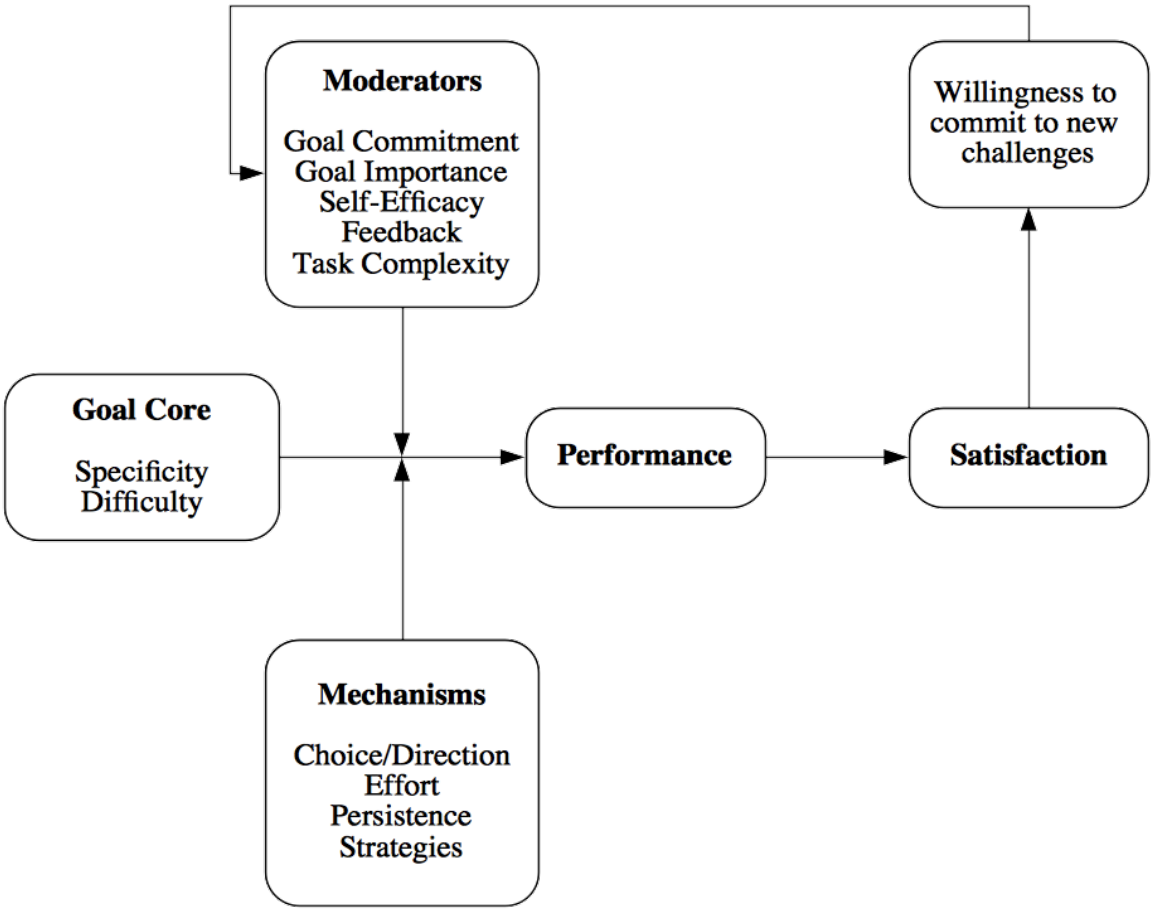


Figure 2-8: Elements of Goal Setting Theory (adapted from Locke and Latham 2002)

The attainment of goals, leads to increase in satisfaction. The level of satisfaction is related to how well the goal was achieved. Lower performance generally leads to lower satisfaction. Satisfaction with one's performance then leads to the willingness to commit to new challenges and also influences one's self-efficacy for future tasks.

In the travel behaviour field, GST has been applied in some car use reduction studies (e.g. Loukopoulos, Jakobsson *et al.* 2004; Loukopoulos, Jakobsson *et al.* 2006), and employed extensively in several Japanese Travel Feedback Programmes based on individualised communication and hedonic feedback (Gärling and Fujii 2006)

2.6. Travel Behaviour Change Experiments

Travel behaviour change (TBC) experiments can be defined as procedures undertaken to test and/or demonstrate the effectiveness of different travel demand management (TDM) measures or policies on travel choices. They are used in investigating and predicting responses of commuters to different TDM measures. TBC experiments typically employ the use of a before-and-after survey in measuring the changes observed in targeted participants and also for understanding factors, which may have influenced behaviour choice (Jones, Gerike *et al.* 2009). Participants of these experiments are usually not isolated from the communities. They may thus be influenced by other factors – such as fuel prices, travel interruptions in one mode, *etc.* – into changing their behaviour, which may not have come from the TDM measure. Control or comparison groups are used alongside the target group to determine these exogenous factors present at the time of the experiment that may have influenced behaviour changes. Control groups are participants drawn from the same sampling population while comparison groups are drawn from a different population with similar attributes to the target group (Stopher, Clifford *et al.* 2009). For example, assuming a suburb is chosen for a TDM measure intervention. A group from the same suburb that will not be targeted with the TDM measure is termed as a control group. A comparison group will therefore be a group chosen from a different suburb with the same or similar characteristics as the targeted suburb. Changes in the experimental groups are usually compared to those observed in control or comparison groups in order to better put the effect of the intervention in perspective. Participants are usually assigned randomly to either experimental and control groups in order to alienate introducing bias into the results (Gärling and Fujii 2006).

Comparison groups may be preferred to control groups as they reduce the degree to which such groups get influenced by the TDM intervention especially if it is targeting large portions of the population.

Based on travel behaviour and behaviour change theories – either implicitly or explicitly – TDM polices have been formulated and executed in efforts at changing travel behaviour choices, mostly from unsustainable modes to much more sustainable modes of transport. TBC experiments have been developed over the previous decade in which TDM strategies have been applied in various ways, based either explicitly or implicitly on some of the theoretical frameworks discussed above. These TDM strategies can be categorised into those using either structural or psychological strategies in changing behaviour (Steg 2003). Structural strategies – comprising physical changes, financial-economic stimulation, and legal regulations – aim at changing the context within which decisions are made. Psychological strategies – involving provision of information and education – aim at increasing knowledge about transport alternatives, and awareness about the impacts (environmental and economic) of decisions, which may affect perceptions, beliefs, attitudes and values.

To explore the link between behavioural theories and experiments, a review and synthesis of travel behaviour change experiments and interventions was carried out (Table 2-2). While this may not be an exhaustive review of behavioural change experiments and interventions, the dominance of the use of theory of planned behaviour (TPB) in predicting and explaining behaviour was evident.

The three main TDM measures used in the different experiments reviewed included: information; incentives (mainly in the form of reduced or free bus tickets); commitment; and feedback. These measures were used either in isolation or as a combined measure. The given of information was aimed at either changing attitudes, or increasing the perceived behavioural control through the distribution of maps, public transport schedules *etc* (Bamberg and Schmidt 1999; Bamberg 2006). The given information was also used to cause dissonance among respondents (Beale and Bonsall 2007) and to trigger adjustments in personal norms by increasing awareness of consequences and responsibilities (Hunecke, Blöbaum *et al.* 2001; Matthies, Klöckner *et al.* 2006). Incentives were mainly aimed at increasing the perceived behavioural control of respondents (Heath and Gifford 2002; Bamberg 2006; Matthies, Klöckner *et al.* 2006). Commitments and feedback usually go together. While commitments get respondents to set goals in making behavioural changes, feedback helps them to get back on track or lock-in behavioural changes (Fujii and Taniguchi 2005; Taniguchi and Fujii 2007).

Table 2-2: Summary of travel behaviour change experiments

Underlying Theory	Author/s (year)	Travel behaviour change experiment or intervention	Key results
Theory of planned behaviour	Bamberg (2006)	A total of 169 newly located residents took part in the experiment. The experimental group (n=79) received a one-day (free) ticket to try the local bus service. They also received personalised information including a map of bus services and stops, schedules and fares. The free ticket and personalised information were assumed to influence participants perceived behavioural control and attitude, and thus intention to change behaviour. The selection of newly relocated households for participation indicates that HFT also informed in the experiment design, as these households had recently experienced a life cycle event in which their habits were disrupted.	An increase in public transport use from 18% to 47% and decrease in car use from 50% to 33% were observed among the experimental group. An increase in public transport use from 18% to 25% and decrease in car use from 50% to 45% were observed in the control group.
	Bamberg and Schmidt (1999)	Following university-wide referendum, bus fares were significantly reduced through the introduction of a semester ticket for university students. New bus routes connecting the main facilities on campus to the city centre were also introduced. The introduction of the semester ticket and bus routes were assumed to impact attitudes (e.g. public transport regarded as cheap and convenient), subjective norms (through public discussion and voting) and perceived behavioural control, which in turn were assumed to adjust intention to change behaviour. A total of 3,491 questionnaires were sent out in the first panel wave of three panel waves. At the end of the third panel wave, 618 completed questionnaires were received. No control group was used.	A significant increase in bus use from 15% to 31% coupled with a decrease in car use from 44% to 30% was observed when semester tickets were introduced. No significant increase in bus use was observed after the introduction of new bus routes.

Underlying Theory	Author/s (year)	Travel behaviour change experiment or intervention	Key results
Theory of planned behaviour	Beale and Bonsall (2007)	Marketing material with information about the benefits of bus travel and the disadvantages of car travel was provided to participants in a first trial after an initial interview to correct their inaccurate beliefs. A total of 205 interviews were received at the end of the first trial, out of which 103 participants had received the marketing material (experimental group) and 102 participants put into a control group. In a second trail, one group of infrequent bus users was provided with only marketing materials about the benefits of bus travel, while a second group was provided with marketing materials and a free bus ticket. A sample size of 71 participants was divided into three groups – 25 in information only group, 23 in information and ticket group and 23 in the control group. The intervention was targeted at correcting negative behavioural beliefs and therefore attitudes toward bus use.	After the first trial, 7.8% of the participants in the targeted group reported increase in bus use as against 3.9% in the control group. A decrease in bus use was however reported by 19.4% of the targeted group as against 15.7% of the control group. Of significance, however, was the slower attrition rate of bus users among habitual bus users in the target group (6.5%) than in the control group (15.4%). About 48% and 48% reported bus use among the information only and information and free ticket groups respectively, as against 30% in the control group after six weeks. Both information only and information and free ticket groups reported about 62% bus use as oppose to 47% bus use in the control group after six months.
	Taniguchi and Fujii (2007)	Participants (n=410) were given information and free tickets to use bus services. Respondents were also encouraged to make travel plans on how to use the ticket. A control group of 85 participants was used. The provision of bus information and tickets enabled the adaption of perceived behavioural control, and thus intention to change behaviour. The formulation of behavioural plans by an experiment group suggests GST was implicit in the experiment.	The proportion of experiment group using the bus (38%) was more than double that of the control group (18%)

Underlying Theory	Author/s (year)	Travel behaviour change experiment or intervention	Key results
Theory of planned behaviour	Heath and Gifford (2002)	The cost of bus use was reduced by the introduction of a universal-pass to university students. The introduction of the universal-pass was assumed to influence attitudes and perceived behavioural control, and thus intention to change behaviour. A before questionnaire also contained questions regarding intentions to use bus services and attitude toward bus use, suggesting that GST was implicit in the experiment. A total number of 175 students completed the questionnaire. No control group was used.	A 7% decrease in driving alone was observed while bus use increased by 11%.
Norm activation theory	Hunecke *et al* (2001)	Free subway tickets were provided to participants who would otherwise use their car or motorcycle for trips to the city centre. Through a before questionnaire, information about ecological problems and impacts was also passed on to participants, aimed at increasing awareness of consequences and personal responsibility, and adjusting personal norms. Two groups were thus formed, the experimental group consisting of 83 with tickets and a control group of 77 without tickets (n=160).	About 61% of trips to the city centre by subway against 39% by car or motorcycle were observed amongst participants with a free ticket whiles 43% of trips by subway and 57% by car or motorcycle was observed in a control group Travel mode choice was influenced by both external cost and personal norms.

Underlying Theory	Author/s (year)	Travel behaviour change experiment or intervention	Key results
Norm activation theory	Matthies *et al* (2006)	A total of 297 participants were grouped into four – the commitment preceded by free ticket group (n=130), the free ticket only group (n-53), the commitment only group (n-61) and the control group (n-53). The free tickets (valid for 14 days) for the tickets only and the commitment preceded by ticket groups were given to participants in the first phase. The tickets were collected and participants in the commitment preceded by ticket group and commitment only group were made to choose at least one of the commitments on a ten alternative list of activities aimed at saving the climate in the second phase. Persuasive information on the negative effects of car use on the climate was also given. This was to activate personal norms towards saving the planet. It was assumed that in the process of participants' committing to a behaviour change, personal norms were addressed, and that the chance of behaviour change actually occurring was increased.	The percentage of people in the 'commitment preceded by free ticket' group trying out the public transport increased from about 7.0% to 16% when they were given the free tickets. It then decreased to about 8% after the tickets had expired and commitments made. It however increased to about 12% during a follow up, two weeks after the commitment phase and decreased to about 10% about 4 months later. A short-term increase of public transport users from about 12% to 17% was observed in the 'commitment only' group after the commitment phase with no increase observed after 4 months. A continuous increase in pubic transport users was detected in the 'free ticket only' group with no significant increase in the control group.
Stages of change model	Mutrie *et al* (2002)	Participants (n=145) received a targeted 'walk in to work out' pack, which included information on walking and cycling routes and safety information. A control group of 150 participants did not receive the intervention. These information packs were formulated based on the stages of change model. The intervention targeted people contemplating, and those preparing for, active commuting.	Participants in the contemplation stage walked 11.5 km per week six months after the intervention as compared to 5 km per week in the control group. Those in the preparation group added 2.3 km per week walking to that observed at baseline, compared to 0.8 km per week in control group. 25% of participants at the contemplating or preparation stages were actively commuting after twelve months.

Underlying Theory	Author/s (year)	Travel behaviour change experiment or intervention	Key results
Stages of change model	Rose and Marfurt (2007)	A ride (cycle) to work day event was promoted by issuing booklets with information on bicycle routes and facilities to participants at various workplaces. The information booklets and events were targeted at people contemplating the use of a bicycle. No control group was used.	80% of first time cyclist indicated the event had a positive impact on their readiness to cycle to work with 57% indicating it influenced their decision to cycle. 25% of first time cyclist still cycled to work five months after event.

Underlying Theory	Author/s (year)	Travel behaviour change experiment or intervention	Key results
Underlying theory not explicitly stated	Fujii (2007)	Non-driving first year university students (n=178) were grouped into five groups: cost (n=38), risk (n=34), stress (n=35), a combination of all three (n=36) and a control group (n=35). They were asked to read leaflets containing cost, risk and stress information about using cars according to their group. The provision of information on predicted personal impacts suggests that TPB (influencing attitudes) and CDT (highlighting dissonance between desirable and likely outcomes) were implicit in the experiment.	53%, 39%, 30% and 47% of student respondents obtained drivers' licenses holders in the cost, risk, stress and all information groups respectively – compared to 69% in a control group after 18 months of intervention.
	Fujii and Kitamura (2003)	A one-month free bus ticket was given to student car drivers (n=23) along with a bus route map to facilitate public transport use but not to drivers in the control group (n=20). The ordering of behaviour change before attitude change suggests that SPT was implicit in the experiment.	A mean frequency in bus use of 9.34 trips/month (an increase of 5.21 or 126% from baseline) was observed in the experiment group during the validity of bus ticket. This however reduced to 4.95 trips/month (an increase of 0.83 or 20% from baseline) a month after the free ticket expired.
	Fujii and Taniguichi (2005)	Individualised information and advice on reducing car use was given to two groups (n=292). One of the groups was asked to make behavioural plans with respect to reducing car use. No control group was used. The preparation of behavioural plans, to influence intention to reduce car use suggests that GST was implicit in the experiment.	A 28% reduction in total trip duration and a 12% reduction in car-use days by the planning group were observed. No significant changes in the advice group were observed.
	Wen *et al* (2005)	Information containing bus schedules, fares, maps, bicycle and walking routes were provided to workers (n=51) through events, poster displays and newsletters. No control group was used. The provision of information on bus services and non-motorised transport alternatives as a means of influencing perceived behavioural control suggests that TPB was implicit in the experiment.	An increase from 37% to 45% was observed of staff reporting use of active transport as their usual commuting mode. There was a 20% reduction in the proportion of staff who reported driving to work five days a week.

2.7. Summary and Conclusion

Identified theories relevant to travel behaviour choice and change have been argued to be categorised into four main groups on the basis of the questions they primarily look to address.

Firstly, theories that explain how choices are made when a decision-maker is confronted with a set of behavioural alternatives – including; rational choice theory (RCT), prospect theory (PT), and habit formation theory (HFT). These theories look primarily at the process an individual goes through when making choices. They do not necessarily postulate factors influencing choice making. RCT and PT posit that a deliberate evaluation of alternatives occurs whenever a commuter is faced with a decision-making problem. HFT may be thought of as building upon the RC theory. It acknowledges an individual goes through an evaluation process the first time he/she is faced with a decision-making problem. In contrast, though, HFT posits that these evaluations may only occur when a decision is made for the first time. The evaluation process may then be scripted into the individual's memory if the outcome of the deliberation proved favourable, thus if the decision maker was satisfied with the option chosen. The memory scripts may then be drawn upon whenever the decision maker is confronted with similar choice problem without going through the deliberation process again. Deliberation process tend to diminish the more the decision maker is required to make a choice in the same context, thus deliberation eventually yields to habits. RCT may support interventions such as pricing which may cause individuals to re-evaluate their choices, while HFT supports the targeting of individuals experiencing life course events like residential relocation.

Secondly, theories that explain what factors affect choice-making include: the theory of reasoned action (TRA), theory of planned behaviour (TPB), the theory of interpersonal behaviour (TIB) and norm activation theory (NAT). These theories attempt to identify the range of factors that come into play when a behavioural choice is made, but do not explicitly explain the cognitive process through which a particular behavioural alternative is chosen with the exception of TIB. TIB attempts to explain the cognitive process through which behavioural choices are made. It may be thought of as a bridge between the first and second categories of theories. It posits an inverse relationship between intentions and habit during the choice-making process. These theories have argued beliefs – personal, societal and control – and emotions as some of the factors that influence behaviour. These factors can be influenced through the provision of information as an intervention.

The third category of theories looks at explaining when behavioural change occurs and the process through which change is made. These include, cognitive dissonance theory (CDT) and the stages of change model (SCM). These theories attempt to explain when a change in behaviour is likely to occur, and identify factors that lead to this change. HFT may also be categorised under this group, as it also attempts explaining when habits are broken – that is, when change occurs – and factors which may lead to a break in habits.

Fourthly, theories that explain how decision-makers respond to behaviour change interventions, and the strength of their responses that include: self-perception theory (SPT) and goal setting theory. Contrary to most attitude theories, SPT posits individuals may change their attitudes by enacting a particular behaviour, that is, behaviour influences attitude. GST then focuses on how well behavioural changes are attained through the setting of specific, challenging, achievable and appropriate goals. Interventions such as the issuance of free public transport passes have been observed to encourage commuters into using public transport modes, leading to changes on their attitudes towards them.

The first two categories of theories may be considered as behaviour choice theories as they show how and what factors affect choices, while the last two categories of theories may be considered as travel behaviour change theories – a distinction which Darnton 2008 considered very appropriate as they may have different roles at different stages of a travel behaviour change intervention.

Despite undergoing criticisms, RCT has dominated as the underlying framework of travel behaviour analysis practice and transport planning. PT, HFT, TPB, SCM and GST have, however, been receiving growing attention in recent decades. TIB, NAT and CDT, however remain largely unexplored in the transportation field.

The theory of planned behaviour was seen as the dominant underlying theoretical framework of many experiments through the review of behaviour change experiments. This was consistent with reviews undertaken by Ajzen (2011) and Bamberg and Schmidt (1999). The theory of interpersonal behaviour remains largely unexplored in the travel behaviour change experiment field, despite its higher predictive power as demonstrated by Bamberg and Schmidt (2003).

An inspection of the literature on travel behaviour change experiments – from the perspective of the theoretical categorisation – indicates that while authors might explicitly identify one particular theory as having informed the construction of their experiment, other theoretical frameworks may also be apparent. The categorisation of theories presented demonstrates that a combination of different theories may not necessarily be contradictory, and that theories may not be mutually exclusive. A good example of this is Bamberg's (2006) experiment involving recent home movers and the provision of free public transport tickets and personal schedule information. Within the explicit theoretical framework of TPB, the information and incentive were designed to influence participants' perceived behavioural control and attitudes, and thus intention to change behaviour. The targeting of recent home movers, however, draws from HFT and in doing so recognises that these households are most susceptible to attempting behavioural change. Further, the new information provided on public transport services may be contrary to participants' prior beliefs, causing dissonance and inducing behavioural change. Thus CDT may also overlap or complement TPB.

There appears, therefore, to be no one right or wrong theory, and there is considerable potential for theoretical innovation in travel behaviour experiment constructions. It is suggested that it is important for formulations of TDM interventions to address the four main question categories identified in this section: how choices are made; what factors influence choices when change is executed; and how decision-makers respond to interventions. There is the need for better understanding of the factors that influence choice making in order to answer the first two questions in the formulation of a TDM intervention. This should lead to the establishment of whether the mode choice is rational or habitual which will in turn lead to the nature with which mode use changes are made. Context specific experimentation is also deemed important in order to determine the possible response of decision-makers to the intervention. The experimentation also helps in identifying a variety of external factors (e.g. quality of mode alternatives, prevailing safety and security perceptions, *etc.*) that may influence on outcomes.

Chapter 3. Travel Behaviour Patterns – Insights from Qualitative Mobility Biography

3.1. Introduction

Travel demand management (TDM) measures can be categorised either as a voluntary or non-voluntary measure. Successfully implemented non-voluntary TDM measures are generally more effective at changing behaviour as commuters are forced into doing so. They are, however, resisted by the public unlike voluntary TDM measures that are less contentious (Thorpe, Hills *et al.* 2000; Taylor and Ampt 2003; Eriksson, Garvill *et al.* 2006; Loukopoulos 2007). Voluntary measures are, however, seen to be less effective as compared to non-voluntary measures as behavioural changes are left to the commuter. Voluntary TDM measures are most likely to succeed when targeted at commuters most susceptible to behavioural change (Loukopoulos 2007).

For an effective formulation and implementation of a voluntary TDM strategy, an understanding of travel behaviour patterns and changes is vital. This includes the process through which a decision is made, what influences choice making and when change occurs. Some authors have argued this process of choice making as habitual, depicting a fairly stable travel pattern (Verplanken, Aarts *et al.* 1997; Gärling and Axhausen 2003; Schlich and Axhausen 2003; Klöckner 2004). Others have argued it to be deliberative, depicting a variable travel pattern (Simon 1955; Scott 2000; Bateson 2010). The assumption of whether mode use choice is rational or habitual may influence the accuracy of predicting behavioural change responses to different TDM measures. Most often, behavioural change between two behaviours or choices is assumed to be unidirectional. Such changes has, however, been shown to be happening in both directions – a concept introduced by Goodwin (1999) as 'churning'. Thus, as some change from behaviour "A" to behaviour "B", others change from behaviour "B" to behaviour "A".

This chapter gives an account of a study done to investigate the dynamics of mode use changes over time in the context of Cape Town. It starts of by looking at the dynamics of travel behaviour patterns, providing the basis for arguing the need for longitudinal data instead of cross-sectional data in order to be able to better explain these behaviour patterns. This led to the formulation of research questions, which served as a guide for the study. The various methods for the collection of longitudinal data are then touched upon. The choice of retrospective data collection method is then justified along with measures taken to improve the reliability of the data collected. A description of the survey tools is then given along with how the surveys were carried out. The data collected is then analysed and discussed.

3.2. Dynamics of Travel Behaviour Patterns

Many studies have been conducted, in various contexts, to understand the dynamics of travel choices resulting in behaviour patterns. These studies in travel behaviour change have mostly acknowledged the repetitious nature of travel patterns. The argument arising in the literature is the extent of deliberation in making travel choices. Some have argued, or at least implied, that decision makers do deliberate on their alternatives whenever they are faced with a decision-making problem (e.g. Fishbein and Ajzen 1975; Ajzen 1991). These studies may be thought of as drawing from the theoretical framework of rational choice making as advanced by Simon (1955; 1957; 1991). Travel patterns resulting from this theoretical framework may be stable only when the outcome after deliberation is always the same – signifying a stable travel environment. It may result in variable outcomes in an unstable environment, introducing variability in travel patterns. When the travel environment is highly unstable, the use of rational choice making theory is most likely to result in variable outcomes.

Other studies have suggested travel behaviour is habitual (Verplanken, Aarts *et al.* 1997; Gärling, Fujii *et al.* 2001; Bamberg, Ajzen *et al.* 2003; Gärling and Axhausen 2003; Garvill, Marell *et al.* 2003). Travel choice making has been argued to be of a complex process, and the fact that commuters make such choices swiftly implies that they do not always deliberate fully on making them (Cullen 1978; Gärling, Fujii *et al.* 2001). These studies suggest that commuters engage in rational deliberation of alternatives only when faced with a decision-making problem for the first time. If the outcome proves successful, the same alternative is chosen whenever the commuter is faced with a decision-making problem in the same or similar context. A concept termed as script-formation by Gärling, Fujii *et al.* (2001). As the same choice is repeated over and over again, it becomes habitual and deliberation becomes less and less whenever choices are being made. This is in line with the theory of interpersonal behaviour (TIB) where the effect of deliberation becomes less as behaviour becomes more habitual (Triandis 1977). With little or no deliberation over alternatives, the same choice may be transferred to other contexts different from the one within which such a choice was made. Habitual behaviour suggests a fairly stable travel pattern as the same choices are made every time.

Inducing deliberation in choice making has been seen to be a means of potentially breaking habits (Garvill, Marell *et al.* 2003). Measures for inducing deliberation include the provision of information about alternatives, creation of awareness about consequences of mode use, provision of incentives *etc.* (Fujii, Gärling *et al.* 2001; Fujii and Kitamura 2003; Gärling and Fujii 2006). Depending on the strength of the habitual behaviour, these measures may be overlooked by individuals. Van der

Waerden, Timmermans *et al.* (2003) identified two salient factors – 'key events' and 'critical incidents' – that may compel commuters into reconsidering their travel behaviour. Key events are defined as expected major events in one's personal life. Examples of key events include: the acquisition of a driver's license, changes in employment, residential relocation, getting married, car ownership *etc.* Critical incidents – which may also be termed as 'life shocks' – on the other hand are defined as unforeseen events that can impact one's behaviour. Examples of critical incidents include: involvement in car crash, muggings, termination of employment, *etc.* Key events and critical incidents may be considered as naturally occurring as they do not require any policy interventions like the latter measures. The occurrences of these two factors are seen to trigger the process of deliberation on travel choices. They may also alter the set of travel alternatives available to an individual. In line with the habit formation theory, the individual may try different travel mode choices before settling for the most suitable option. This introduces a degree of variability in a fairly stable travel pattern (see Huff and Hanson 1986; Cherrett and McDonald 2002). This variability may be termed as of the 'short-term'. Other causes of short-term changes include routinized variation in travel pattern and once-off interruptions in the travel environment. Routinized variation refers to planned alternation between travel choices – e.g. an individual may decide to travel with public transport from Monday to Thursday but travel with private vehicle on Friday. Examples of once-off interruptions may be due to unforeseen events such as break down of private vehicle *etc.*

Variability is not only seen in mode use choices but also in other attributes of travel choices such as routes and departure times. The extent of variability or habit is however, different in the various attributes of travel choices. Commuters have been found to first change their routes and departure times before considering a change in mode use (Dowling and Colman 1995). This means variability in mode use choices are minimal compared to that experienced in route and departure times. Goodwin (1989) from a study about the stability of public transport use found that, individuals whose circumstances change in terms of key events and/or critical incidents are more susceptible to travel behaviour change. Changes observed were reciprocal and not only in one direction, thus while some were moving from alternative 'A' to 'B', others were moving from alternative 'B' to 'A', a phenomenon known as 'churning' (Goodwin 1999; Chatterjee 2001). Most often the magnitude of these changes are not of the same magnitude in opposite directions, introducing a phenomenon termed as 'asymmetric churn' (Goodwin 1999). The unequal magnitudes of change in the two directions result in a net change, which may be mistaken as a one directional change when data are analysed in

aggregate form. This net change can be swayed in either direction. It is considered positive if it is favourable and negative if unfavourable. This natural phenomenon introduces variability in all aspect of travel choices including mode choice.

3.3. Research Question and Proposition

Based on the review of the literature, the following research questions have been formulated to understand the prevailing travel behaviour dynamics in Cape Town.

- Are travel choices among commuters habitual or deliberate?
- In the absence of TDM interventions, what triggers travel behaviour change?
- How frequently do these triggers occur?
- What theory/theories best explain travel patterns among commuters in Cape Town?
- Are mode use changes uni-directional?

Answering these questions is deemed to help in understanding the travel behaviour patterns of commuters in Cape Town. It will also help in ascertaining or disproving the proposition that lower middle-income car commuters in Cape Town engage for long periods of time in non-deliberative habitual mode choice behaviours, which are changed when infrequent key life course events or incidents induce deliberation. Thereby helping solve the apparent contradiction between habit and variability. Thus, middle-income car commuters do not engage in daily deliberation on the mode of transport to use, rather they get locked into the habit of using the same mode of transport. This process of mode use choice is hypothesised to last until the commuter experience a key life course event or incident which forces them to reassess their mode of transport, introducing a stage of variability in what may seem like a fairly stable habit.

3.4. Research Method

To be able to determine the variation or habitual nature of travel choices and behaviour, there is the need for data to be collected over longer periods of time (Huff and Hanson 1986; Schlich and Axhausen 2003). Cross-sectional surveys have often been used in traditional transportation surveys in the collection of data (Lanzendorf 2003). This type of survey collects data at a specific point in time. Its variant, repeated cross-sectional surveys have been used in the collection of data over a longer

period. Data collected through repeated cross-sectional surveys are however from different samples at the different point in time they are carried out. It is therefore difficult to determine the causalities of changes, which may be observed. Cross-sectional surveys or repeated cross-sectional surveys are therefore not suitable if variations in travel behaviour and their causalities are to be determined. Longitudinal or panel data is therefore needed in order to fully analyse the dynamics of travel behaviour patterns.

3.4.1. Survey Instrument Design and Data Collection

To establish the dynamics in travel patterns due to long and short-term variability, a mobility biography was employed in this study. A mobility biography may be defined as a longitudinal record of an individual's commuting choices over time. Longitudinal data is thus, needed for the construction of an individual's mobility biography (Lanzendorf 2003; Beige and Axhausen 2006; Lanzendorf 2006; Otto 2010). Three major methods for the collection of longitudinal data include; panel survey, pseudo-panel survey and retrospective survey (Axhausen 1995; Lanzendorf 2003).

3.4.1.1. Panel Survey

Panel surveys involve the repeated survey of a group of people over a period of time at regular intervals (Lanzendorf 2003; Stopher, Clifford *et al.* 2009). It is considered the most reliable method for the collection of longitudinal data since errors due to memory loss are minimal as time elapse between activity and data collection is almost immediate (Kitamura 1990; Raimond and Hensher 1997; Kitamura, Yamamoto *et al.* 2003). There are, however, some disadvantages with the use of panel surveys, among which include the lengthy time between start of survey and when data is delivered, respondent attrition, the conditioning effects on respondents, and the high cost of survey (Lanzendorf 2003). The lengthy time in data delivering, along with respondent attrition may cause a significant reduction in the number of respondents at the end of the survey. These may be due to death and lack of interest in the survey at certain points in time. One may therefore have to start off with a very large sample size, hoping to get to the required sample size at the end of the survey. This may lead to high cost of survey and considerable sampling bias. Aside from these, respondents may get accustomed to the line of questioning, which may affect future answers.

The use of a panel survey in the study was not feasible as the study aimed at establishing mode use changes of respondents in the working life. The survey could thus only rely on past data if there were available.

3.4.1.2. Pseudo-Panel Survey

Pseudo-panel surveys may provide some alleviation of the disadvantages of a panel survey such as the lengthy time before data is delivered and the high cost. Pseudo-panel surveys involve the construction of cohorts, which are traced through several cross-sectional data that are already available. It is a quick and relatively cheap method of delivering longitudinal data. The main disadvantage with this method, however, is that observations are done at an aggregate level and changes in individual behaviours are not accessible. This makes it impossible to construct a mobility biography – which involves individual choices – from this method.

The aim of the study was to determine the causes of individual mode use changes. Individual mobility biography data was therefore needed for the study. The impossibility to construct mobility biography from such data made it impossible to use the pseudo-panel survey method in this study.

3.4.1.3. Retrospective Survey

A retrospective survey was seen to be the only viable survey method for the mobility biography study in Cape Town due to the limitations and infeasibilities of panel and pseudo-panel surveys.

Retrospective surveys are once-off surveys used in the collection of information about an individual's past activities (Auriat 1991; Beckett, Vanzo *et al.* 2001; Behrens and Del Mistro 2006). They have been used in a variety of research fields, including psychology, epidemiology, sociology, demography, marketing and health (Haaga 1988; Mathiowetz and Duncan 1988; Peters 1988; Auriat 1991; Friedenreich 1994; Dex and McCulloch 1998; Graham, Catania *et al.* 2003; Smith and Thomas 2003; Jordan, Jinks *et al.* 2006; Gibson and Kim 2007). They are seen to be quicker and the most suitable way of collecting information about an individual's travel behaviour history compared to pseudo-panel survey methods (Auriat 1991; Beckett, Vanzo *et al.* 2001; Lanzendorf 2003). Of major concern, however, is the reliability of data collected through this method. The main problem with data collected through retrospective survey is related to memory biases – forgetfulness and telescoping – since they

rely on the memory recall of respondents over extended periods (Auriat 1991; Beckett, Vanzo *et al.* 2001; Belli, Shay *et al.* 2001). Forgetfulness refers to the phenomenon where respondents do not remember the occurrence of an event, while telescoping refers to the inaccurate dating of events (Prohaska, Brown *et al.* 1998; Ziniel 2008). Telescoping can either be forward or backward telescoping. Forward telescoping occurs when events are remembered as having occurred in a more recent time than it actually did, while backward telescoping occurs when events are remembered as having occurred at an earlier time than they actually did. Forward telescoping have been seen to occur more frequently than backward telescoping (Belli 1998; Ziniel 2008).

Problems with recalling past events

Asking respondents about their past behaviour requires them to search particular parts of their memory in order to respond. Sudman, Bradburn *et al.* (1996) described memory as a large storehouse of information of all kinds and understanding how they are organized is fundamental to apprehending how they are retrieved. Information about different events is comprehended, encoded and stored in different parts of their memory. Among these memories are autobiographical memories – thus memories about one's self (Brewer 1994). He identified four types of autobiographical memories – personal memory, generic personal memory, autobiographical fact and self-schema. Personal memory refers to memories stored about single events in one's life. The individual usually has a detailed memory of such events to the extent that they are able to mentally visualise them, e.g. buying a car. Generic personal memory is similar to personal memory in that, the individual hold mental images, but are usually collated mental images of several events, e.g. driving to work place in a car everyday. Memories of single events to which an individual holds no mental image are referred to as autobiographical facts. Self-schema memory is formed when an individual experiences several similar forms of non-image events, e,g one's mode use preference. One or more of these memories are argued by Brewer (1994) to be called upon by respondents in answering research questionnaires.

Searching through the memory bank to retrieve particular items being sought is termed as remembrance. Sudman, Bradburn *et al.* (1996) advanced three processes an individual goes through in answering a question. Firstly, the respondent has to be able to understand the question being asked in order to start the process of memory search. Once the event has been located in the memory storehouse, it is retrieved. Upon retrieval of the event, a judgement is made as to whether the retrieved information is the correct memory before a response is made. Failure of a respondent to give answers

to questions may be due to forgetfulness. Even though forgetfulness is thought to be a function of time, there is no single relation between them, resulting in different forgetting curves with different people and events (Ebbinghaus 1885). Different types of events are forgotten at different rates.

Sudman, Bradburn *et al.* (1996) described three ways by which events can be omitted or forgotten. First, some events may never be transferred to the long-term memory. They argued we pick what to pay attention to, due to limited capacity of our mind's processing power. As such some events are not processed, encoded and stored in the memory. Thus, they are usually forgotten almost immediately after the occurrence of the event. Secondly, events may be omitted due to retrieval failure. This occurs when events are not rehearsed for long times. The cues needed to activate these memories are usually weak due to the fact that they have not been recalled for so long (Sudman, Bradburn *et al.* 1996; Mathiowetz 2000). Alteration of memory is thought to be the third way through which events are omitted or forgotten. Individuals are said to recall past events through a process of reconstruction (Bartlett 1932) and through this process, detailed memories may be lost or altered. Salient event memories remembered first are usually used as cues to recall detailed memories.

Telescoping errors may still be prevalent, even when an individual is able to recollect a memory of an event. Telescoping is said to be caused by a combination of three independent factors (Rubin and Baddeley 1989; Sudman, Bradburn *et al.* 1996). First is the normal relationship between time and the rate of forgetfulness. Recently occurring events are usually remembered much easier than those occurring further back. Thus, errors in dating events increase the longer the time between the occurrence of the event and when it is recalled. Errors in dating events were observed by Janssen, Chessa *et al.* (2006) to be minimal when respondents were asked to recall events that had happened within three years from the time of recall. Also contributing to telescoping is the random occurrence of dating errors. These random errors are said to increase with time elapsed between when an event occurred and the time they are recalled. Thirdly, events that occurred outside the period being referred to may be thought of as occurring in that period. Sudman, Bradburn *et al.* (1996) argued intrusion to only occur from the past events and not events yet to occur. Telescoping may lead to an overestimation of the number of events that may have occurred within a period of time under investigation (Beckett, Vanzo *et al.* 2001).

An understanding of how memories are organized and stored, how they are retrieved and appreciating errors associated with the process of retrieving memory information is important in identifying methods to aid in the recalling process.

Retrospective recall-aid techniques

Remembering an event is argued by Sudman, Bradburn *et al.* (1996) to be influenced by habitual behaviour, emotions, attitudes and events happening at the time of retrieval, which include the wording and context of questions. The phrasing of questions, which will serve as cues to trigger memory search is therefore important. Free recall, cued recall and recognitions are three methods of recalling classified by psychologists (Sudman, Bradburn *et al.* 1996). Open-ended questions – where respondents are provided with minimal cues - are examples of questions triggering free recall. Example, "what are some of the factors you think about when deliberating on mode use choice?" Cued recall may be similar to free recall methods, but here, respondents are given detailed cues in the questions. Example, "some commuters often think about cost, convenience and safety when deciding on their mode use choice. What factors do you think about when deliberating on mode use choice?" Questions providing specific list of things an interviewer wants to ask about are said to trigger the recognition recalling method. Example, "do you think about cost when deciding on mode use choice? Do you think about safety when deciding on mode use choice?" Retrieval failures by respondents have been seen to be minimal with recognition and cued recall methods than with free recall method (Sudman, Bradburn *et al.* 1996).

Belli (1998) pointed out three memory retrieval pathways; top-down, sequential and parallel retrievals which are tied to autobiographical memories – that is memory of one's personal past. Autobiographical memories are structured hierarchically (Barsalou, Neisser *et al.* 1988; Conway 1996), on top of which lie memories for extended events usually spanning over years and others over a few days. Some of these events referred to as lifetime events are easily remembered as they determine one's self-concept (Belli 1998). Lifetime events may be personal or public, however, personal lifetime events are seen to be better remembered than public lifetime events (Ziniel 2008). Summarized memories of repetitious events are next on the hierarchy. At the bottom of the hierarchy are those of specific events, which may be contextual in nature, spanning over minutes or hours. The basic principles underlying the structure of autobiographical memory are considered to be thematic – that is, with reference to types of events and/or persons – and temporal – that is, with reference to time or

sequence of events (Sudman, Bradburn *et al.* 1996; Belli 1998). Specific and summarised event memories are considered to be nested in extended event memories. Top-down retrieval refers to the relationships that exist between major events and smaller ones; thus information about extended events may lead to the recall of specific events (Conway and Bekerian 1987; Barsalou, Neisser *et al.* 1988). Sequential retrieval refers to the chronological sequencing of events as they happened. It is based on the temporal arrangement of memories. Sequential retrieval is most apparent when respondents are asked to recall events over longer periods of time (Belli 1998). Parallel retrieval may be similar to sequential retrieval as events may also be arranged chronologically but across two life domains (e.g. employment and travel life domains) while sequential retrieval is across one life domain. Retrieval pathways are interconnected and encouraging the use of cues available in these interconnected pathways increases the recall of autobiographical memory. Parallel retrieval may be thought of as of the highest order in retrieving past events as they are likely to incorporate the other two types of retrieval pathways.

Survey questionnaires and recall-aid tools were designed bearing in mind how memories of events are organized and how they are retrieved. A combination of open ended and cued questions were used in the questionnaire (see appendix A). Commuting and event history calendars were also used (see appendices B and C). This was to help aid respondents into remembering better, meaning better quality data.

Commuting History, Event History and Deliberation Calendars

Traditional survey questionnaires have been found to only encourage a top-down retrieval pathway of memory recall and not of the others (Belli 1998). The use of history calendars – events and commuting – has however been seen to encourage multiple and interconnected retrieval pathways in autobiographical memory recalls (Belli 1998; Belli, Shay *et al.* 2001). Some of the advantages of using event history calendars (EHC) are their potential in improving data collected through retrospective surveys and ease of recording detailed sequences of events (Freedman, Thornton *et al.* 1988; Belli, Shay *et al.* 2001). Also of importance is the easy detection of inconsistencies of the sequence of events across different life domains.

Changes in employment, residency, co-habiting partnerships, children, driver's license and car ownership were chosen as life events for the construction of an event history calendar. These life

events were chosen as they have been seen to have effects on the transportation needs of individuals. The household composition – that is co-habiting partnerships, children – have been seen by Heine, Mautz *et al.* (2001) as cited by Lanzendorf (2003) to affect car use. Employment has been seen to have ripple effects on mode use changes. Getting employed may increase a person's economic power, which may lead to the acquisition of a car, changing their mode use (Lanzendorf 2003). Changes in employment and residency may alter distance between trip origin and destination, which may trigger mode use changes.

Using these life events, a life event calendar (appendix B) was developed in conjunction to a commuting history calendar (appendix C). The commuting calendar comprised of the different available modes that are commonly used for work trips in Cape Town – walking, car, minibus-taxi, bus and train. These were used as memory recall aids. Data were to be used for the construction or determination of long-term variability in travel choices.

3.4.1.4. Travel Diaries

A travel diary is used for documenting personal trips over a period of time. It records attributes of travel choices such as the origin, destination, travel time, mode choice *etc*. It has been used in transportation surveys for the collection of longitudinal data for understanding and measuring daily travel behaviour patterns of individuals and households (Axhausen 1995; Lanzendorf 2003). It is very advantageous in collecting data on travel patterns as they give detailed choices but can be very expensive if used for long durations. Schlich and Axhausen (2003) recommended a minimum duration of two weeks of observation if the aim of using a commuting diary is to determine habit or variability in travel patterns.

To aid in the determination of short-term variability or habit of travel choices among respondents, a two-week commuting diary was designed and used in this study (see appendix D). Some of the attributes, which were captured with the commuting diary, included; whether trip origins, trip destination and route choice remained the same as previous day, arrival times at work, travel mode used and car occupancy. These were recorded for both trips to and from work.

3.4.1.5. Sample Design and Selection

Long-term mobility studies have mostly been based on either secondary data or data collected through retrospective surveys (Müggenburg, Busch-Geertsema *et al.* 2015). This may be due to the time-consuming and costly nature of collecting longitudinal data through panel survey. Other mobility studies have been short term where data is collected from a panel before and after an intervention (Bamberg, Rölle *et al.* 2003; Fujii and Gärling 2003; Garvill, Marell *et al.* 2003; Eriksson, Garvill *et al.* 2008; Ben-Elia and Ettema 2011). Participants' selections for these studies have mainly been a combination of probabilistic (where each individual has a known probability of being selected) and non-probabilistic (where some of the population have no chance of been selected) methods of sampling. This has been due to the nature of such mobility studies that have demanded for certain categories of commuters. The population is usually screened to ascertain if they meet the criteria. For example, Ben-Elia and Ettema (2011) used license plate recognition cameras to identify their targeted sampling population. They were then to travel at least three times a week to work and have email and internet access in order to qualify to be selected for the study. Chatterjee, Sherwin *et al.* (2013), recruited participants based on how they had answered a previous survey about their use of bicycles.

A non-probabilistic method of sampling was used for this study as participants needed to satisfy a certain set of filtering questions in order to be eligible to answer the questionnaire. Participants were selected based on a snowball sampling method. Few known respondents who were deemed to likely fit the criteria set for the questionnaires were approached. They were only asked the main questions after they had satisfied the criteria set out by asking the preceding questions. Individuals who were approached were then asked to recommend people they thought would meet the criteria set out, whether they themselves met the criteria or not. Respondents were required to be employed at the time of the survey, and requiring regular travel to the same place of work. This was seen as a proxy to habit formation in terms of mode use. Respondents were also required to have changed their mode use at least once in their working life, and needed to be between the ages of 30 and 63 years as the study aimed at finding triggers of mode use changes to work over long periods. Respondents were to have lived more than half of their working life in Cape Town, which was the context within which the study was been carried out. Switching between public and private travel modes was argued to be common among lower middle-income earners as car ownership start to be more evident (SA DoT 2012 p. 42). For this, the study mainly targeted middle-income earners. The income and age criteria were, however, not adhered to strictly to enable capturing some high-income respondents and young professionals.

Sample may therefore not be representative of the general public. This was acceptable as the study was to enable an in-depth study of triggers of mode use changes among habitual commuters.

Sample sizes have been linked to the type of surveys, thus whether quantitative or qualitative (Ritchie, Lewis *et al.* 2003; Neuman 2014). Sample sizes for qualitative surveys have been observed to be smaller than those of quantitative surveys. Neuman (2014) attributed this difference in sample sizes to the different purposes for which sampling serve in qualitative and quantitative studies. While sampling is used in quantitative studies to create a representation of features in the population, that of qualitative studies is to gain insight and understanding about issues in the population. One major reason given by Ritchie, Lewis *et al.* (2003) for the small sample size in qualitative surveys is the point of diminishing return – thus the point where adding more data does not lead to new observations. They argued an observation only need to appear once for it to be of relevance to the study and not about the number of incidence. The concept of saturation therefore helps in estimating the sample size for a qualitative survey theoretically. Its practicality in the determination of sample size has however been questioned by Guest, Bunce *et al.* (2006) as the process is subjective. Determination of the point of saturation has been argued to be dependent on the experience and discretion of the researcher (Tuckett 2004; Mason 2010). This may have led to the different sample sizes recommended by different authors for a qualitative survey (see Guest, Bunce *et al.* 2006). Ritchie, Lewis *et al.* (2003) recommended a sample size of less than 50 will be enough to achieve saturation for a study that uses individual interviews as the method for data collection.

3.4.1.6. Data Collection

Observation, interview, and questionnaire are some of the main methods of collecting data. These have been used in the collection of mobility data over the years. Observation involves the acquisition of data by observing an individual. This usually involves the usage of tracking devices in mobility studies, for example, Ben-Elia and Ettema (2011) tracked the movement of respondents by installing transponders in their vehicles. A major advantage of the observation method is the direct collection of behavioural data without relying on the accounts of the respondent (Foster 2006) Observational methods therefore produce more accurate data compared to the other two types of data collection. Respondents may however, alter their behaviour, either consciously or unconsciously when they come to know that they are being monitored. The observational method may also be expensive, with data lacking causality information. They have therefore been used mostly to compliment data collected

through either interview or questionnaire method. Interviews involve verbal communication between a respondent and an interviewer. Interviews may be classified into two main categories – unstructured and structured interviews (Phillips and Stawarski 2008). Follow-up questions in unstructured interviews are usually formulated based on the response given to previous questions. They may therefore vary from respondent to respondent. Semi-structured interviews are guided by written down questions, which must be covered. They ensure information is consistent to a certain degree among respondents. Questions in structured interviews are fixed and asked in a specific order. They may resemble the questionnaire method where the questions are also fixed and in specific order. Respondents are however expected to read and fill in the questionnaires themselves unlike the case of interviews where an interviewer read the questions (Wilson and Sapsford 2006).

Interviews can be administered through phone or face-to-face conversations while questionnaires are administered through post or internet – either electronic mail or on a web page. Interviews allow for explanation of questions if needed by respondents, which is not possible in the case of questionnaire surveys. Acquisition of data through interviews also guarantees all the necessary questions are answered by the respondent unlike through the questionnaire method where the respondent may skip some questions especially when the questionnaire is paper-based.

With the help of colleagues, a face-to-face interview was used in the collection of data in March 2012. This was to augment data collected in 2011 with the help of colleagues. Using a semi-structured interview, commuters were asked questions about their work trips over their working life. Participants were asked questions relating to the occurrence of selected lifetime events in their working life. These events included changes in employment, residence, co-habiting, children at home and schooling, driver's licence and car ownership. These events were used in constructing a life event history calendar. This was to aid respondents in cross-referencing their responses to commuting choices and improving the reliability of their recall. This was to help determine the various life course events that may have influenced mode use changes. To test the variabilities that may be apparent in the day-to-day travel choices, respondents were then given a two-week commuting diary to be filled. This was later collected from respondents on an arranged date. Diaries were not always completed before the arranged dates. In such cases, respondents were made to recall their commuting trips over the last two weeks when collections were been made. The diaries are then filled together with the respondents.

Figure 3-1 depicts a typical respondent's mobility biography showing the mode switches over his life span and their causes. The respondent as at the time of the interview was going to work as a passenger of a car. The train was the mode of transport to work when he started working in 1979 when he didn't have a car. He switched to being a car passenger in 1981 as a result of switching jobs. Respondent remained a car passenger until he bought his own car in 1982, after which he started driving to work. He reported changing jobs, residence and co-habiting in that same year. He continued driving to work till the year 2009 despite the occurrences of different life course events such as changing residence, co-habiting, having children at home and starting schooling. It took a life shock – when he had to give his car to the wife after a friend that had been giving her a lift moved away – to cause him to change back to being a car passenger.

A total of seventy (n=70) full-time workers who commute to the same place of work on regular basis (i.e. excluding service providers like plumbers and sales representatives who travel to different work destinations) were interviewed. Most of these commuters (accounting for about 60%) were middle to lower income earners. The sample size of 70 was within the range of sample sizes (between 1 and 95) used by different authors carrying out qualitative surveys and more than the average of 31 as compiled by Mason (2010).

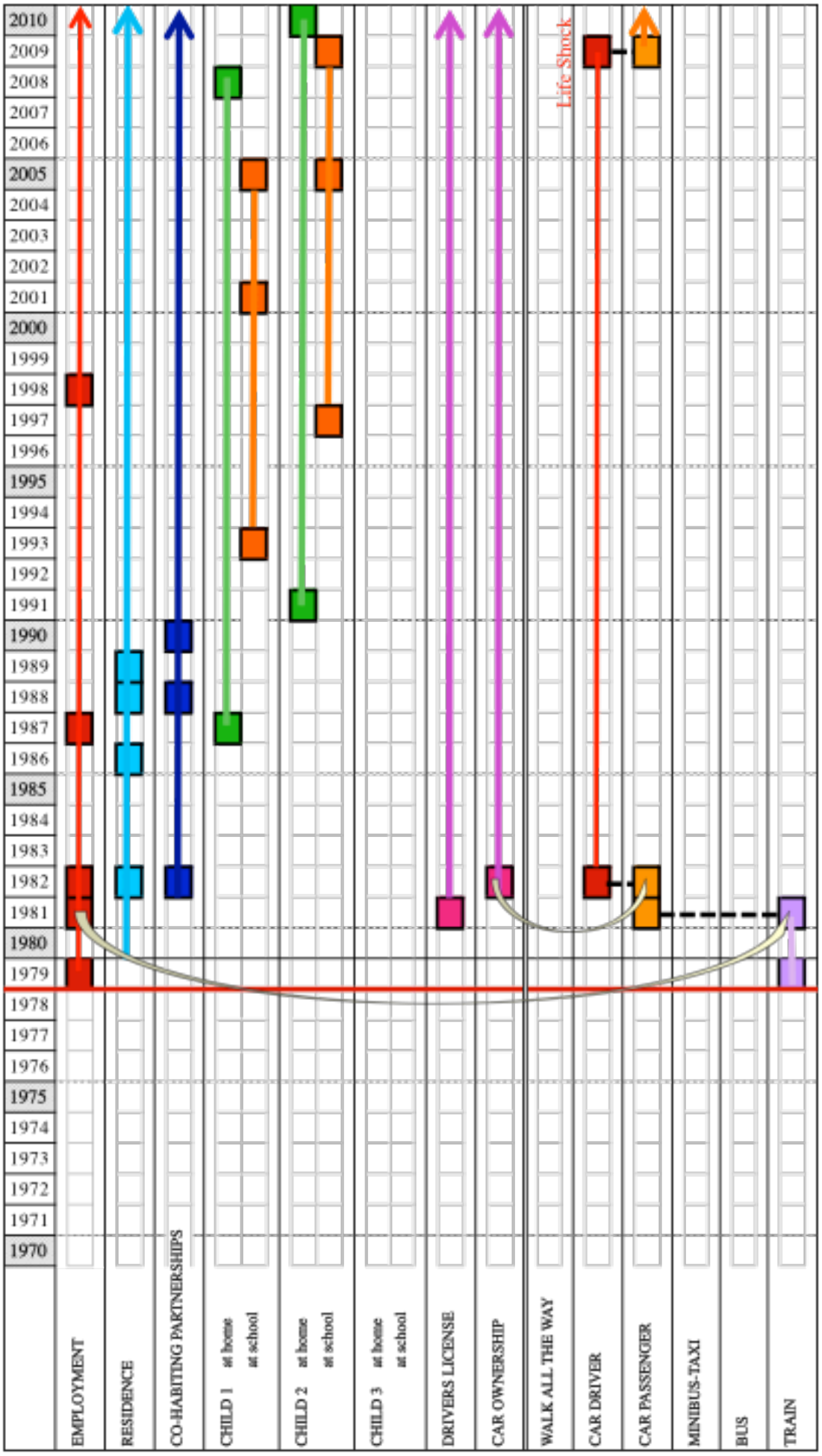


Figure 3-1: Example of an event and commuting history calendar (male, 56 years, high income respondent)

3.4.2. Analysis

Collected data were entered into a Microsoft Excel worksheet for analysis. The modes of transport used by each respondent were recorded over their working life. This was recorded along with life course events or critical incident that may have occurred in their life and the year in which they occurred. It was noted whether a life course event caused a change in mode use or not. The number of life course events occurring among the respondents was aggregated, noting the percentage that caused changes in mode use. A chart of individual mode use over the observed years was plotted to visually see the trend in mode use changes. The duration with which respondents used a mode of transport before changing it was noted and aggregated to estimate the habitual nature of mode use. This was also to evaluate the triggers of travel behaviour change in the absence of TDM and the frequency of their occurrence. Analysis was augmented with quotes from respondents explaining the causality of their behaviour change.

Respondents' day-to-day mode use choices were analysed from the trip diary data for the aspects of mode use that exhibit variability or otherwise. The different attributes such as origin, destination, departure time, arrival time, route choice, mode of transport and car occupancy were aggregated for all the respondents. The percentage of days to which their choices changed from that of the previous day was computed as the extent of variability in that attribute of mode use choice. Departure and arrival times within 10 minutes of the previous day were considered as being the same.

3.5. Results

3.5.1. Descriptive Analysis

A total of seventy respondents were interviewed. Table 3-1 presents a break down of the socio-demographic characteristics of the respondents. The respondents were grouped based on their income earned per month. Respondents earning below 5000 ZAR (approximately 612 US dollars as of June 2012) were considered as low income, those earning between 5000-10000 ZAR as middle income and those earning above 10000 ZAR (approximately 1225 US dollars as of June 2012) as high income. They were further stratified according to their gender and age. All respondents were currently employed, requiring regular travel to the same place of work and have changed their way of travelling to work at least once in their working life – which was made possible because of the selection questions. About 60% of respondents were middle to lower income earners with a near equal split between male (53%) and female (47%).

Figure 3-2 shows the residential neighbourhoods of respondents. Most of the respondents were at the time of survey living in the Cape Flats, City Centre, Southern Suburbs, and Northern Suburbs. They were mostly living along railway lines.

Table 3-1: Socio-demographic characteristics of sample respondents

Row Labels	Female					Male					Grand Total
	<30	31-40	41-50	51-65	Total	<30	31-40	41-50	51-65	Total	
<5000 ZAR	1	4	3		8	3	6		2	11	19
5000 – 10000	1	2	5	4	12		1	5	6	12	24
>10000 ZAR		3	5	5	13	1	6	5	2	14	27
Grand Total	**2**	**9**	**13**	**9**	**33**	**4**	**13**	**10**	**10**	**37**	**70**

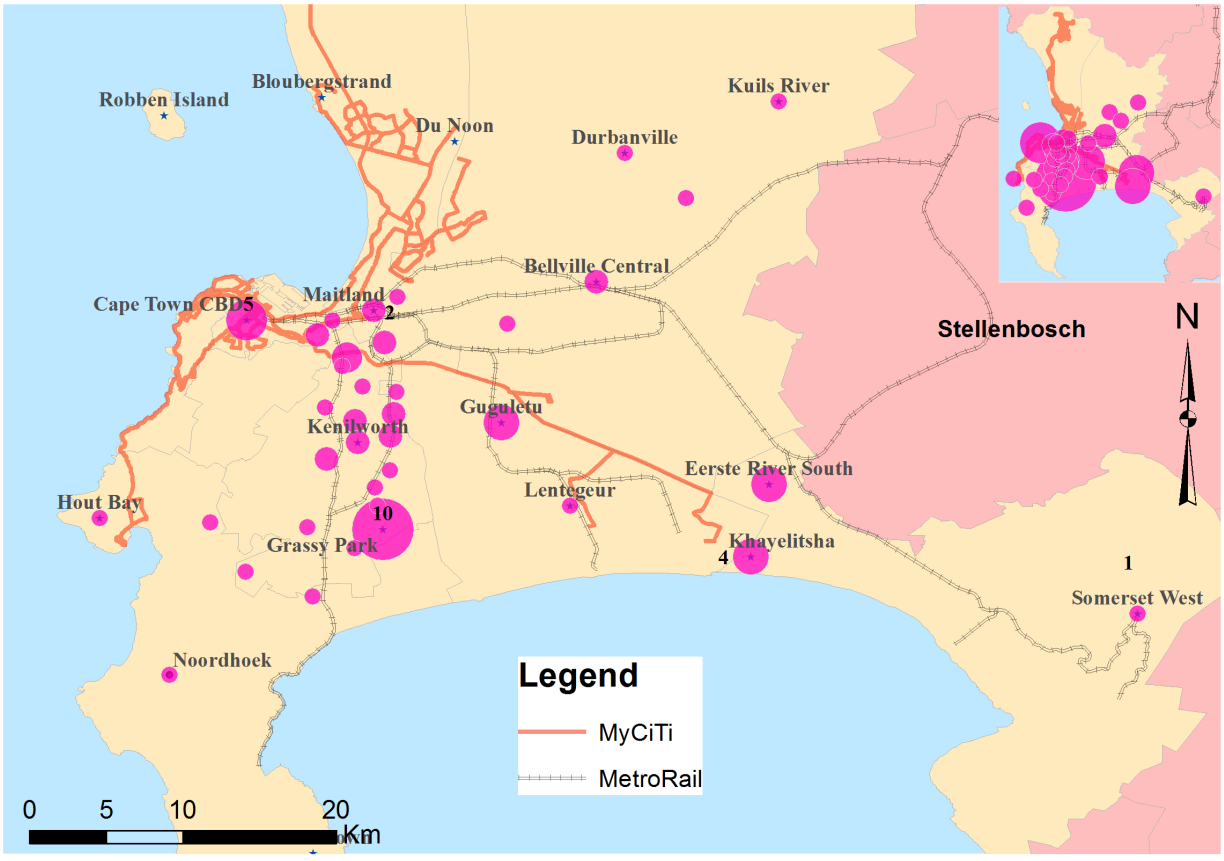


Figure 3-2: Spatial distribution of respondents

3.5.2. Short term Dynamics

To determine the extent of variability or otherwise in the different attributes of travel choices (i.e. trip origin, destination, departure and arrival times, route, mode use, and car occupancy), the travel diary was analysed. A total of 26 travel diaries were completed, representing about 37% of the respondents.

The 26 returned diaries resulted in a total of 240 days. Figure 3-3 depicts the percentage of total days observed from the sample where certain attributes of the work-trip remained stable (i.e. resembled behaviour on the previous day) and the percentage that displayed variability. A variance of 10 minutes was allowed for departure and arrival times. Times falling within this allowance were considered to be same. Among all the attributes of work trips, the origin and destination were seen to be the most stable, whether from home or work (it should, however, be noted that one of the criteria for respondent selection was a job that required commuting to the same place of work, so trip destination variation associated with more mobile service industry jobs such as plumbers, electricians *etc.* is not reflected in the respondent data). Thus 100% of all cases had not changed their work place or residence during the two-week survey. Also experiencing complete stability was the number of people in the car on the work trips. About 17% of the trips to home, however, did experience day-to-day variability in car occupancy. Other attributes generally showing variability were found to be the departure times, arrival times, route choice and activity along the way. The arrival times in both trips to work and home were observed to show more variability than departure times. It is however, worth noting the relative stability of the departure times (93%) and route choice (95%) of home trips. The mode use choice was also relatively stable; with about 96% and 97% stability of trips to work and home respectively. Among the respondents showing variability in mode use choices, only one had access to a car as an available mode to choose from (Table 3-2). This highlights the relative stability of mode use choice among car users.

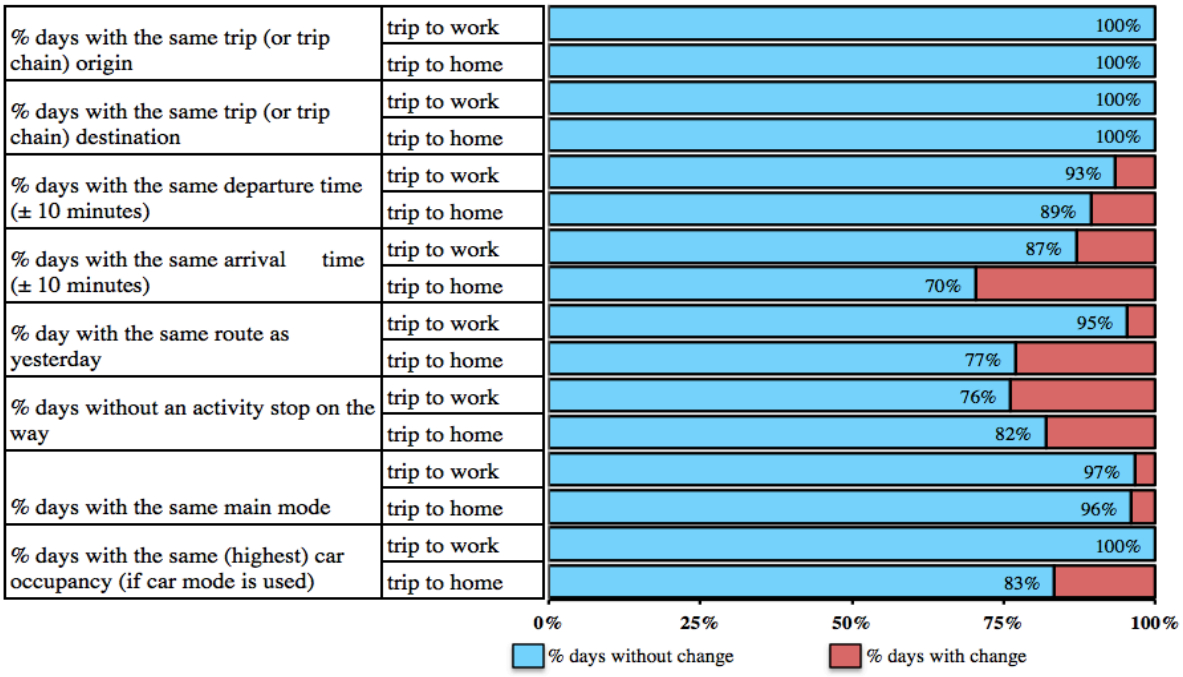


Figure 3-3: Observed short-term variability in different attributes of work trips

Table 3-2: Respondents with mode variability

Respondent's ID	Access to car mode?	Work trips			Home trips		
		Number of trips made	Number of days variable	% of variability	Number of trips made	Number of days variable	% of variability
OM02	No	-	-	-	10	1	10%
OM03	Yes	10	2	20%	10	2	20%
OM04	No	-	-	-	10	3	30%
TJ02	No	10	1	10%	-	-	-
TJ10	No	10	2	20%	-	-	-
TJ16	No	10	4	40%	10	4	40%
Total		**40**	**9**	**23%**	**40**	**10**	**25%**

3.5.3. Long term Dynamics

As noted in the previous section from the analysis of travel diary data, the mode use choice was seen to be habitual, especially among car users. To establish the extent to which mode use choice is habitual over the longer term, the mobility biography data was analysed. Table 3-3 depicts the mean durations between sustained mode use changes, categorised by gender and age. As expected, the mean duration between travel behaviour changes is long, providing evidence of how habitual mode use is over the long-term. Respondents were found to take on average about 6 years before changing their mode use. There was no significant difference found between the mean mode use durations of a male respondent

and that of a female respondent. This was not so with age where the mean mode use duration was found to increase with age.

Table 3-3: Mean duration between sustained mode use changes

	Gender		Age (years)				Total
	Male	Female	<30	31-40	41-50	51-65	
Number of respondents	37	33	6	22	23	19	70
Mean duration between sustained mode use changes (years)	5.9	6.5	4.0	5.7	5.3	8.3	6.2

The habitual nature of mode choices was also obvious from the responses received from respondents; some of which are illustrated in the examples below. Mode use choice among some respondents were observed to have been influenced by their experiences from their past behaviour – a proxy for habit in behavioural theories such as the theory of interpersonal behaviour. They chose a particular mode because they were familiar or comfortable with such modes.

> *"… when I started working in 1995, I was using the train. I lived in Grassy Park and worked in Cape Town [city centre] to 2006, so it was convenient for me to take the train; I knew what to do with the train. In 2006, I got a new job, which required me to live on the work premises. You could say that I walked to work at that time. In 2008, I was retrenched and I moved back to Grassy Park. I didn't have a job for a while. When I got a new job in Cape Town [city centre], I went back to using the train, just like I used to do when I first started working. I suppose I was used to the train from before, that is why I went back to using it." (a 33 year old male lower income respondent).*

> *"… once I got my first car, I never used anything else. I suppose I got comfortable using a car. Even if me and my husband are forced to share a car, I will always be the driver because I often go out at lunchtime and I need to have the freedom to go where I need to when I need to"(a 65 year old female high income respondent).*

It was also clear from the responses that some respondents only evaluated available alternatives when he or she was faced with choice problem for the first time – an assertion by habit formation theory – as illustrated in the example below.

> *"… in 1981, I moved house after marriage… I lived close to the train station. I just stopped and thought through things and thought, let me take the train. I was closer to the station and it was cheaper. … when I was deciding on the way to travel to my work place in 2000, I decided to use the train, partly because I was used to the train. I knew what to expect. You know I have never though about why I have only used the train, why I have never considered another public transport mode" (a 52 year old male lower income respondent).*

From the above statement, the effect of 'key events' on triggering mode use change was also clear. Among the changes in life course events, changes in employment were seen to be the major key event causing changes in mode use after analysing the mobility biography data (Table 3-4). It accounted for about 50% of all mode use changes. This was followed by changes in residences and car ownership, accounting for about 16% and 17% of the mode use changes observed respectively. Changes in children's schooling and the attainment of a driver's licences were found to be the least common key events triggering changes in mode use. 'Critical incidents' were not found to be a significant cause of mode switching (these form part of the 'other reasons' category in Table 3-4).

Table 3-4: Life course events (LCE) triggering mode use changes

Life course events	LCEs observed		LCEs causing changes in mode use		% of mode use change in relation to occurrence of the LCE
	No.	%	No.	%	
Car ownership	64	5.6	43	16.7	67.2
Employment	290	25.5	130	50.4	44.8
Residence	197	17.3	42	16.3	21.3
Co-habiting partnership	90	7.9	11	4.3	12.2
Household size growth	210	18.5	11	4.3	5.2
Driver's license	38	3.3	1	0.4	2.6
Child schooling	228	20.1	1	0.4	0.4
Others reasons	19	1.7	19	7.4	
Total	**1136**	**100**	**258**	**100**	

To further investigate the impact of these life course events on mode use change, the number of mode use changes in relation to the frequency of a particular life course event is also expressed in Table 3-4.

From this analysis, changes in car ownership were observed to be the most likely life course event to trigger changes in mode use. About 67% of changes in car ownership led to changes in mode use. The acquisition or loss of a car almost always led to a change in mode use among respondents. Ownership of a car led to changes from other mode use domains to car use while loss of a car led to changes from car use to other mode use domains. The 23% changes in car ownership that did not lead to changes in mode use were mostly changes in the type of car, in which case the respondent was seen to still have access to a car. The acquisition or loss of a car leading to changes in mode use – normally from public transport to car use and vice versa respectively – were also evident in responses from respondents as seen in examples below.

> *"… in 1999, I bought my first car, so I started driving and not using the train. I had wanted a car to be more independent. I had many different activities that required travel at that time. A car was the best mode to use to meet all my needs. I got to a stage in my life where I just felt it was the right time to buy a car and start driving…" (a 35 year old male high income respondent).*

> *"… I changed from bus to car use when I got a car in 2002. It was very old but still better than no car. I was happy to get the car, very happy. I had a car accident in 2007 and the car was written-off. I didn't want to stop using the car, but I had to because I didn't have enough money to fix it." (a 29 year old low income male respondent).*

Also evident were changes in employment where about 46% of such changes led to changes in mode use. Changes in employment led to changes in transport modes available to respondents in some cases – thus leading to a change in mode use. In contrast to changes in car ownership leading to move to and from public transport, changes in employment led to changes in all the modes, as illustrated in examples below.

> *"… I moved into a new house in 1986 that was very close to work, so I walked every day… When I changed jobs in 1991, I worked further away and so I started using the train. I used the train every day to travel to work for about two years. When I changed jobs in 1999, I would usually walk to work, as I was again closer to work, and catch a train home, as I was usually more tired after work. When I changed jobs in 2005, I worked further from home and was consistently a car passenger." (a 52 year old female high income respondent).*

'… when I started working in 2003 near my home, I used to walk to work. There weren't actually many public transport options on that route, so I didn't have much of a choice. … When I got a new job in Cape Town [city centre] in 2005, I started using public transport. I would take a taxi from my house to the train station and then a train into town… when I started working in Claremont at the end of 2009, I got a lift to and from work from my boss…" (a 24 year old male low income respondent).

The 'other reasons' cited in Table 3-4 resulted in a 100% change in mode use with most of them being from other modes to private car use. Some of these reasons included the high cost of maintaining the operation of a private car; negative experiences being verbal abuse or car crashes – which may be considered as critical incidents; and awareness of public transport as can be seen from the following comments from respondents.

"… in 1987, I was verbally abused when I was travelling by bus… Nothing like that had happened before, but the experience was so negative I decided to never use the bus again…" (a 63 year old female high income respondent).

"… in 1997 when I turned 21, I was given a car from my parents. In 2000, I had to sell the car because I could not afford keeping it anymore, I started using public transport again, taking the bus to and from work. In 2002, I changed back to car use when I was able to afford one…" (a 31 year old female middle income respondent).

"… in 2009, before the World Cup 2010, there were a lot of promotion of public transport on the radio, so I thought, 'let me try it' … Upon trying it, I realised the train was not as scary as I thought it would be. This was my first time using the train and I have since been using the train…" (a 43 year old female high income respondent).

"… at first I did not know what timetable the buses worked to, and what bus to take to get to work. After I had an accident in a mini-bus taxi, I decided to give the bus a try. I went to the station and found out about the schedule and since then I have been using the bus to work as it is convenient for me…" (a 46 year old female low income respondent).

The above responses show changes in mode use from all the different transport domains to the other among respondents. Figure 3-4, 3-5 and 3-6 show the mode use changes of commuters that are currently using private transport, public transport and non-motorised (walk) transport over their working life respectively. The vertical axis represents the different modes of transport being used with the horizontal axis representing years of mode use. Each point on the chart represents the mode of transport used by a particular commuter in that year. These points are then joined with a line – to delineate the longitudinal patterns of mode use behaviour. The different shades of colour are used to show different modes. Points in the same shade of colour therefore mean the number of respondents using that mode in a particular year.

From analysing the data, the car as a driver was seen to be the most dominantly used mode of transport over the years amongst the respondent sample, followed by the train. The crossing lines show that mode use changes were not only in one direction but also in several directions – evidence of long term 'churning'. Changes were observed between different transport domains, and also within domains. For example in 2003, as commuter A was changing from private transport (car driver) use to public transport (train), commuter B was changing from public transport (bus) to private transport (car driver) use (Figure 3-4). Most of the observed long term 'churning' was between two transport domains. Some changes were, however, observed within transport domains. For example, in 2007, as commuter C was changing from mini-bus taxi to bus use, commuter D was changing from bus to mini-bus taxi – both modes located within the public transport domain (Figure 3-5).

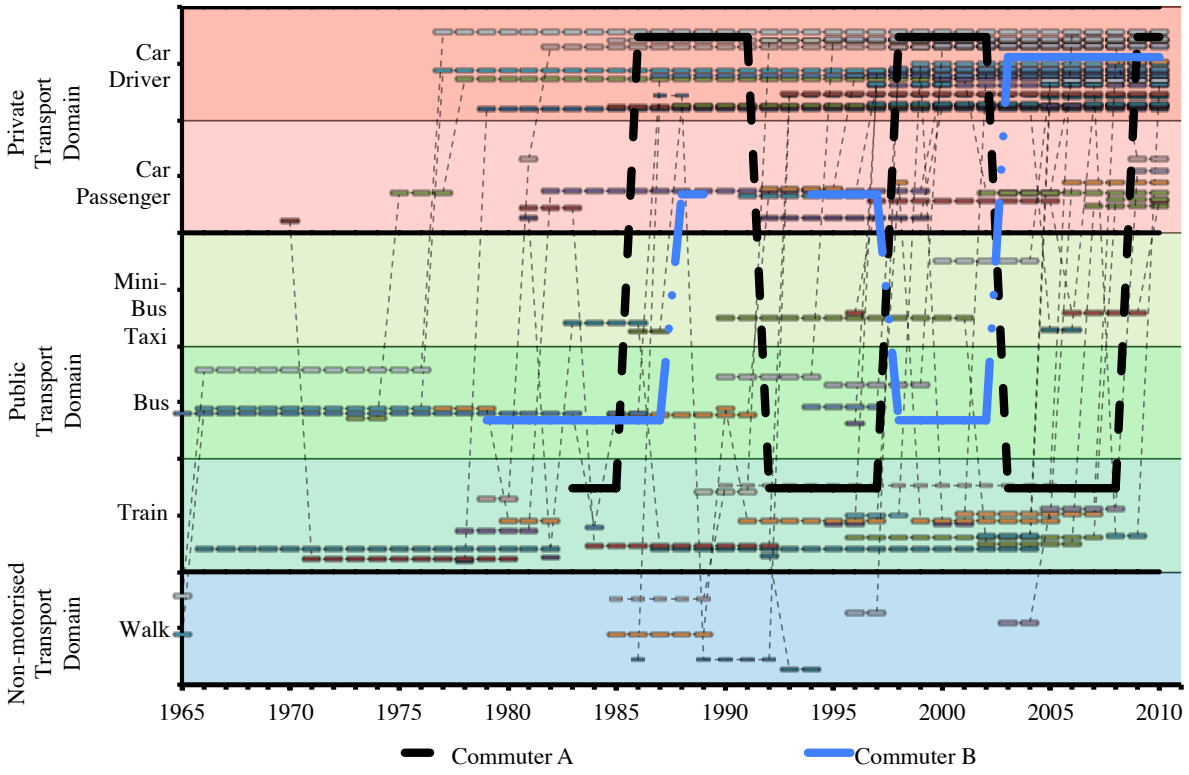


Figure 3-4: Mode use changes among current private transport users (1965 - 2010)

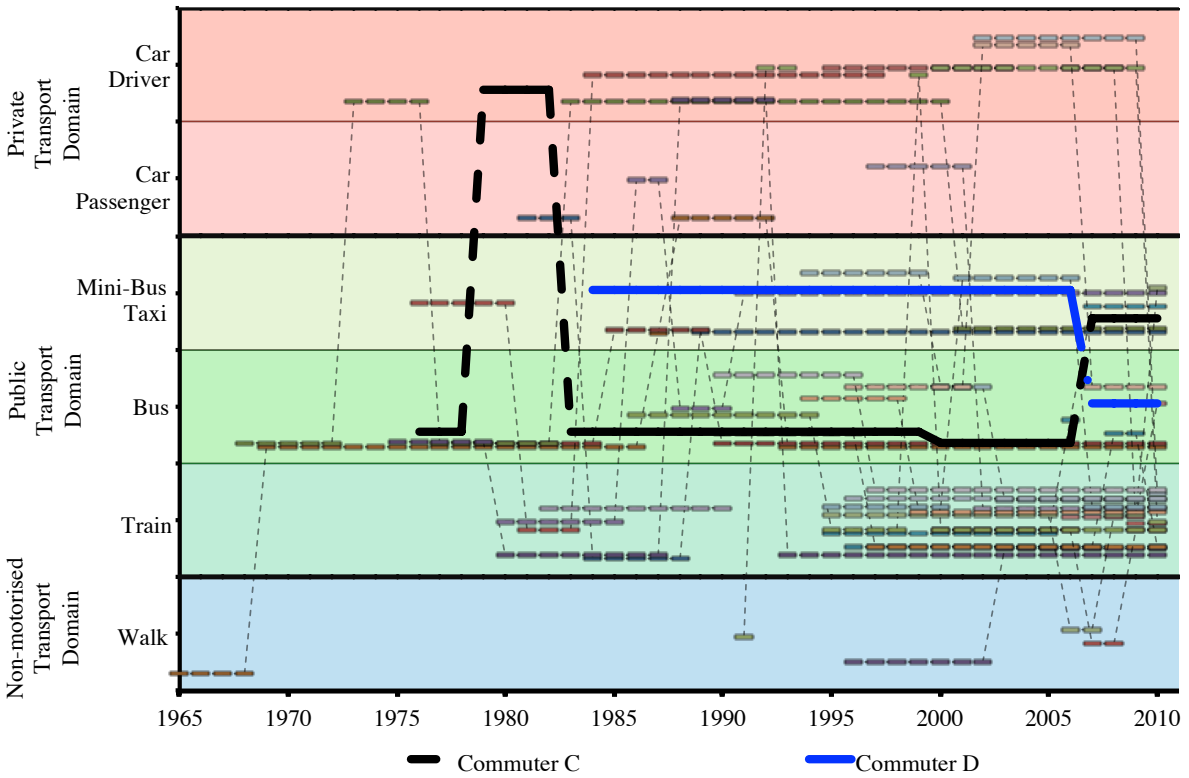


Figure 3-5: Mode use changes among current public transport users (1965 - 2010)

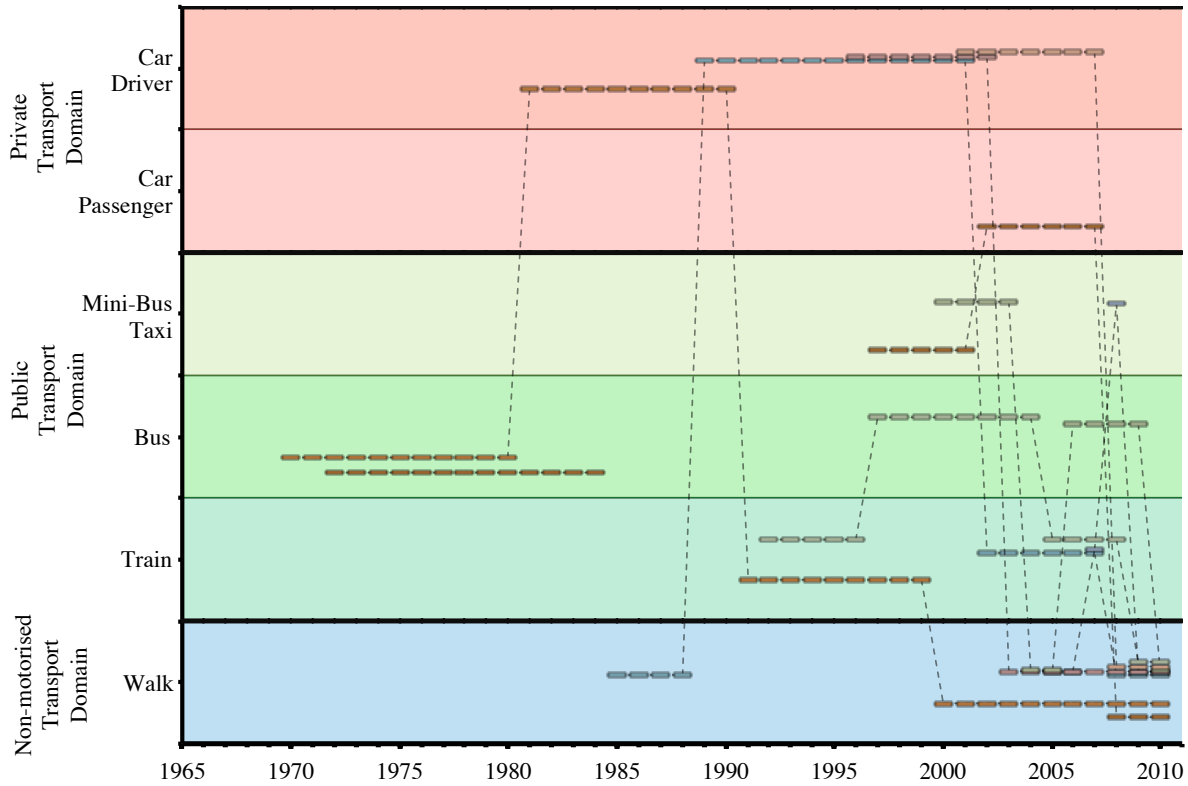


Figure 3-6: Mode use changes among current non-motorised (walk) users (1965 - 2010)

Figure 3-7 shows the different mode use shares over the years. For clarity, the chart has been limited to a ten-year time period, from 2000 to 2010, unlike with figures 3-4, 3-5 and 3-6, where it starts from 1965 – which is the year for which mobility biographies for respondents were recorded from. The main mode of transport amongst the respondent sample over the years was seen to be private car as a driver, followed by the train. Low mode use shares were found for walking and the car as a passenger. The low share of walking may be attributed to long distances between home and work places of respondents, while that of car as a passenger may be a confirmation of the low occupancy rate of cars in Cape Town and the world as a whole. Comparing the different transport domains, public transport mode use share was higher than private transport in 2001, 2002, 2003 and 2004. It then declined relative to private transport use from 2005 onwards. From 2006, the mode use of a car as a driver was higher than all public transport combined to work, which is in line with studies showing high use of private cars to work in Cape Town (Transport for Cape Town 2013). The long-term churn evident in the respondent sample is therefore asymmetrical in nature and moving towards car use.

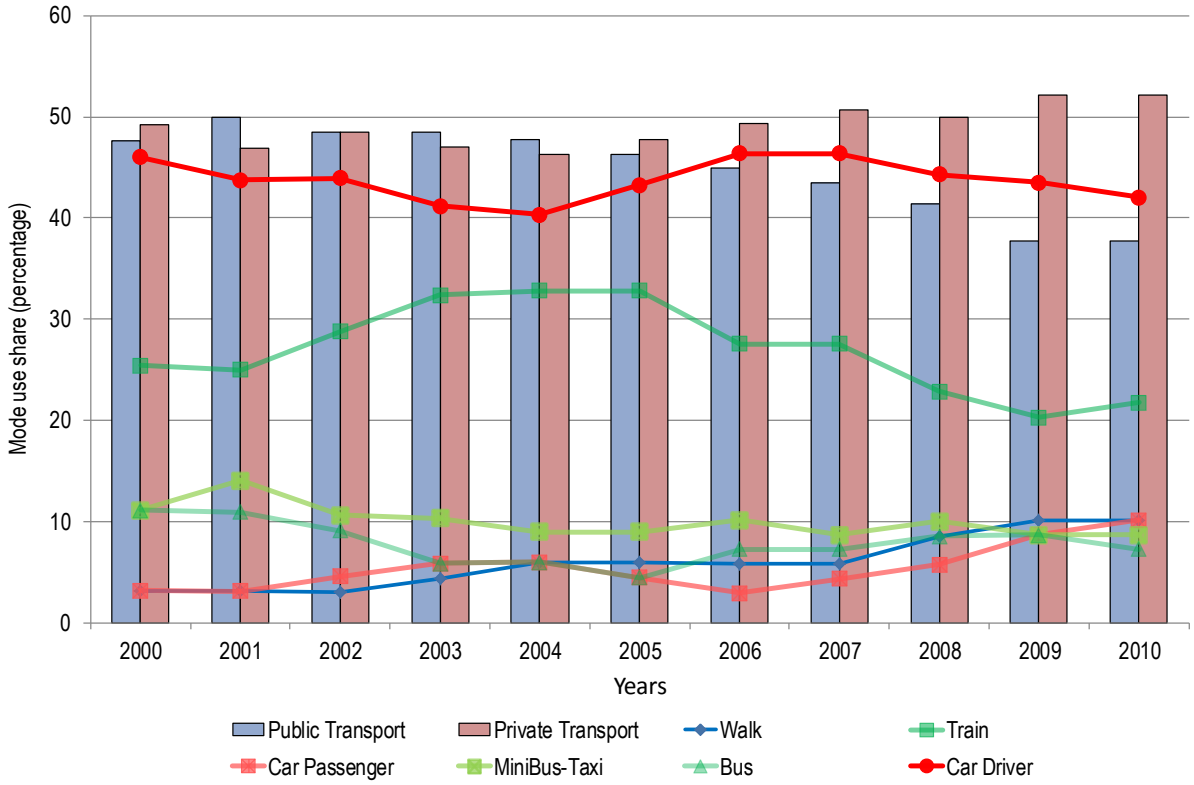


Figure 3-7: Mode use share of respondents (2000 - 2010)

3.6. Discussion

3.6.1. Variability of Different Mode Use Choice Attributes

From the travel diary analysis, the origin and destination attributes of mode use choice were observed to have shown no variability. The stability in work places and residences were expected as changes in these attributes occur infrequently. They were thus most likely not to have changed within the two weeks for which the travel diary was to be completed. Also showing complete stability was the vehicle occupancy for the trips from home to their work place. This could be attributed to the habitual nature of transportation behaviour of the households. For example, a household with children of school going age may have the same occupancy rate as the children may almost always be leaving to school whiles the parent(s) are going to work. The same may not be said for the reverse, where a colleague from work may join the respondent on the trip home. The rest of the mode use choice attributes recorded variabilities to different degrees with arrival times to home, recording the highest variability. The high variability in arrival times may be attributed to the unpredictable nature of traffic on the road – which may be high on one day and low on another. Departure times recorded less variability as compared to arrival times. The relative stability in departure time, especially from home may be due to the fixed start times at the work places of most commuters. Variabilities in route choices were mostly

routinized. Respondents reported sending their children to school, going to the gym etc. This is reflected in the variabilities observed in the activities to and from their places of work.

The relative stability of the mode use choice compared to the other attributes such as departure times, arrival times, route choice, and activities along the way was also expected. This is in line with the literature on habit breaking as people have been found to first look at changing their route and departure times, which require less planning effort and schedule disruption, before considering a change in mode use for commuting, which require greater planning effort (Dowling and Colman 1995).

3.6.2. Effect of Life Course Events on Mode Use

The occurrences of life course events were observed to trigger behaviour changes, even in the absence of TDM measures. Mode use was observed to be more habitual as one gets older. This may be attributed to the relative increased stability in life styles in terms of residences, employments, childbirth, *etc.* as one ages. Changes in younger generations may be more apparent as they may be in the experimenting phase of their life compared to the older generation who may be more settled in life. This is in line with observations by authors such as Beige and Axhausen (2008) where they observed reduction in life course changes with increasing age.

Major life course events observed to be influencing mode use choices have been changes in employment, residence, household size, vehicle ownership, acquisition of driver's license etc (Beige and Axhausen 2008; Clark, Chatterjee *et al.* 2014). This was not different for this study where changes in employment, residence and vehicle ownership were the major causes of mode use changes among respondents. Changes in employment in particular dominated in terms of occurrence and changes in mode use. Changes in employment, especially for better-paying jobs may have an influence on vehicle acquisition, which was found to have a very high probability of causing a change in mode use to private vehicle. Changes in residence also have the potential in altering the modes of transport available to an individual as well as changing the distance between origin and destination, which may then lead to changes in mode use. Other major life course occurrences were changes in household size and children leaving for school. These two life course events along with driver's license acquisition and 'other reasons' – which were observed in fewer quantities – had small effects on mode use changes in terms of the overall mode use changes. The small effect of driver license acquisition on

mode switching was expected as these changes only occur once in a commuter's life. All the 'other reasons' however led to a change in mode use, mostly from public transport to private transport. This was expected, as the 'other reasons' were unexpected occurrences in an individual's life. They were usually bad experiences such as insults from bus conductors.

Changes in mode use caused by the observed life course events were not just from one transport domain to the other but multi-directional, thus while some were changing from public transport to private transport, some were also changing from private transport to public transport, even though it was in smaller quantities compared to the former. This provided evidence for 'churning' and it was asymmetric.

3.7. Conclusion

The study aimed at investigating the dynamics of mode use changes over a commuter's working life, as well as the major key events leading to these changes. The study also aimed at exploring whether or not there was evidence for the existence of long term 'churning' in mode use changes. To investigate the dynamics in mode use changes, mobility biography and commuting travel diary surveys were administered. It was to test the proposition that mode use choice is habitual, and that sustained changes are mainly triggered by the occurrence of lifetime events.

The commuting travel diary was used to assess the variability of different attributes of travel choices of commuters' trips. These attributes included; origin and destination choices, route choice, departure and arrival times and mode use choice. An analysis of the diary data revealed that the origins and destinations of trips remained stable through the two-week diary period. Among the other attributes, mode use choice was fairly stable compared to route choice, departure and arrival times. These were expected, and in line with literature where commuters were found to first change their route or departure times before considering a change in mode use.

To establish the extent to which mode use choices were habitual, the mobility biography data were analysed. On average commuters were found to take about six years before changing mode. This finding confirmed the proposition that mode use choice is habitual – especially among car users over

the long term, despite the evidence of small variations in behaviour especially in the other attributes other than mode choice as found in the travel diary survey.

Mode use changes were observed to be in all directions – providing some evidence of 'churn'. The net change over the long-term amongst the respondent sample was from public to private transport domains – an indication of 'asymmetric churn'. Also evident, however were mode use changes within transport domains.

After analysing the commuting history together with the event history of respondents, changes in car ownership were found to affect mode use changes the most in terms of the number of changes in mode compared to the number of occurrences of that particular key event. Changes in employment were, however, found to be the main causative factor in terms of the total number of changes observed. This was followed by changes in residential location and car ownership.

The study thus showed mode use choices among commuters in Cape Town are habitual and not a decision they deliberate on a daily basis. The habitual nature of mode use choice is however interrupted by the occurrence of life course events or critical incidents, forcing commuters to deliberate on their mode use choice. This makes individuals experiencing such life course events more susceptible to TDM interventions.

Chapter 4. Mode-Use Choice - An Exploration of the Deliberation Process

4.1. Introduction

Mode use choice has been seen from the previous chapter to be habitual among the respondents. Respondents are therefore deemed not to engage in daily deliberation over the mode of transport to use. Habits are broken when commuters are induced to deliberate on their mode use. The occurrences of life course events have been seen to trigger deliberation among respondents as they reassess their mode of transport. Commuters have therefore been argued to be most susceptible to mode use change interventions when they are experiencing life course events.

The influences of life course events on mode use choice have been researched and ascertained by many authors (Klöckner 2004; Stanbridge and Lyons 2006; Beige and Axhausen 2008; Scheiner and Holz-Rau 2013; Clark, Chatterjee *et al.* 2014; Schoenduwe, Mueller *et al.* 2015; Rau and Manton 2016; Verplanken and Roy 2016; Busch-Geertsema and Lanzendorf 2017). There is, however, lack of research into how mode use changes occur when commuters experience these mobility changing life course events. Klöckner (2004) argued two main reasons why the occurrence of a life course event influences the reassessment mode use choices. He argued the occurrence of a life course event may either alter the available modes of transport to an individual or their living conditions. A change in the living conditions and/or available modes of transport causes the individual to deliberate on their mode use choices. He also argued this process to have a psychological aspect to it. He theoretically explained this process by proposing the trajectory for habit, awareness, information seeking and deliberation before and after the occurrence of a life course event. Klöckner moved on to recommend further studies aimed at validating the proposed framework for mode use changes when experiencing life course events. Little research has however been carried out to understand this process of habit breaking. This study sought to explore the habit breaking process by establishing when habits are broken in relation to the occurrence of a life course event, the duration a commuter deliberate on mode use change and some of the information they seek when deliberating on mode use changes. This was to help improve upon the theoretical framework that was proposed by Klöckner (2004). The observations will then be reflected upon, based on the theories of behaviour and behaviour change that was reviewed in chapter two.

This chapter starts by introducing the effect of life course event on the decision making process of a habitual commuter. It sets the tone for the establishment of research questions upon which the rest of the study is based. These questions were setup to gain insight into the dynamics of breaking habits and not to test any specific proposition, as was so in the survey elaborated upon in the previous chapter.

This was due to the lack of sufficient literature around habit breaking, upon which such proposition would have been based on. This led to the selection of research tools such as the deliberation calendar for data collection. These are then analysed and discussed.

4.2. Mode Use Choice: Effect Of Habit On Decision Making

A commuter has been argued to be deliberative when faced with a mode-use choice problem for the first time. The choice is codified if the commuter is satisfied with the mode of transport after using it (Gärling, Fujii *et al.* 2001). Under the same or similar conditions, this choice is repeated, and over time, the behaviour become habitual. Same choices are made even when the conditions under which such choices were made may have changed slightly. This is so because the habitual commuter overlooks minor changes in the conditions under which the choice was made, as they may not be actively seeking new information (Verplanken and Roy 2016; Busch-Geertsema and Lanzendorf 2017). The commuter may have no nudging need to change their mode of transport without any major changes in the conditions, which led to the formation of the habit. The commuters' awareness of the need to change their behaviour - an important antecedent for the enactment of a behaviour as by Schwartz's (1977) norm activation theory – may be low at this stage,. Commuters therefore do not actively deliberate on their travel choices as this stage.

Commuters have to be nudged in order to induce deliberation on their modes of transport. One way of inducing deliberation in the absence of a travel demand management measure has been observed to be the occurrence of a life course event. Influences of habit on travel choices have been argued to weaken when commuters are experiencing a mode use changing life course event (Verplanken and Roy 2016). At this stage, habits are unfrozen or begin to unfreeze, making travel choice decision-making more deliberative. Commuters become increasingly aware of their travel choices and start to deliberate on them. The deliberation may result in a change of mode, which may then be codified once again if they result in satisfactory outcomes. This new habit may be strengthened if the conditions under which the new travel choices were made are maintained for a period of time. The period between when habits are broken and re-formed introduces an opportunity for behavioural change interventions to be targeted, as individuals are deemed more susceptible during this period (Dahlstrand and Biel 1997; Verplanken and Roy 2016). A period termed by Stanbridge, Lyons *et al.* (2004) as a "window of opportunity".

The influences of life course events on habits and travel choices have been well documented in recent years. Little research has however, been conducted to gain insight into how habits are broken. Klöckner (2004) argued the occurrence of a life course event to lead to changes in either the availability of certain modes of transport and/or living conditions of the commuter. This, he argues to cause a sharp increase in the level of awareness among commuters of the need to change their behaviours – termed as the level of activation (Figure 4-1). At the same time, the influence of habit on travel choices decline sharply. Commuters therefore start to actively seek information and deliberate on their travel choices. The level of activation prior to the occurrence of the life course event, thus when commuter travel choices were habitual, is argued to be low. The level of information seeking is also low at this point as commuters do not deliberate on their mode of transport on a daily basis. The levels of awareness, information seeking and deliberation are lowered again, once habits are re-formed after the life course event. The 'window of opportunity' as postulated by Klöckner (2004), may be argued to be starting from when the life course event occurs as he indicated this as the point where the levels in habit, activation, information seeking and deliberation changes sharply.

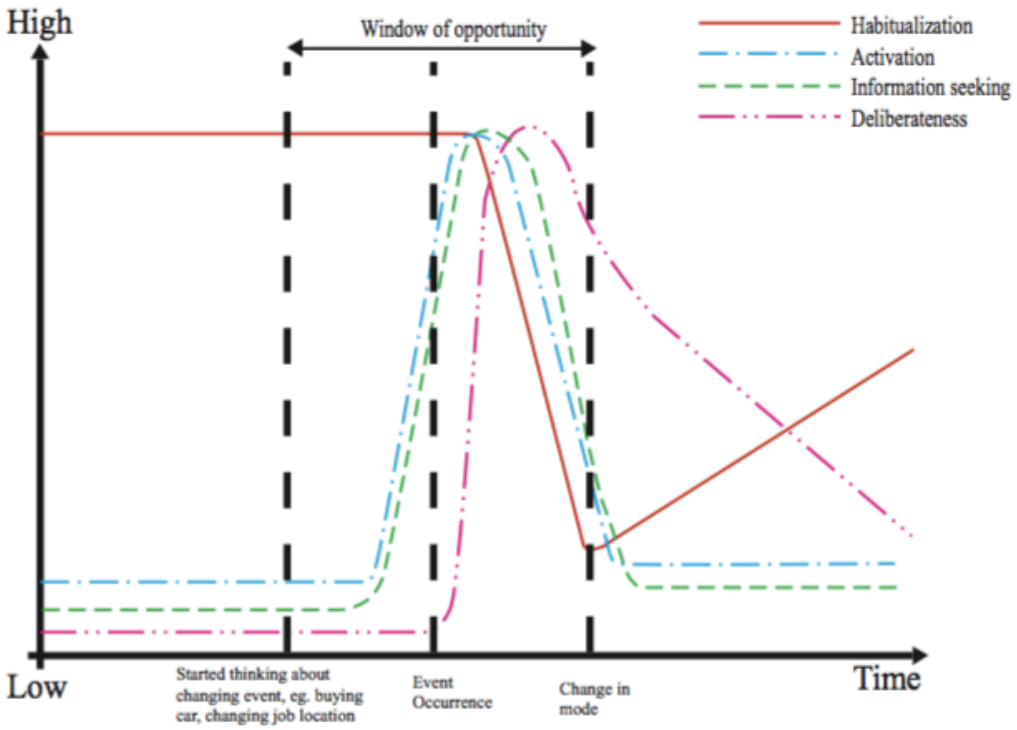


Figure 4-1: Influence of life event on habits, awareness, information seeking and deliberation: adapted from Klöckner (2004)

During this period, an individual may try out different travel mode choices before settling on the most suitable option. This introduces a degree of variability in a fairly stable travel pattern (see Huff and Hanson 1986; Cherrett and McDonald 2002). This variability may be termed as 'short-term'. During this period, a commuter's search for new information about alternative modes of transport is heightened. Commuters are therefore more susceptible to mode use changes at this stage of their life than ever. Travel demand management measures are therefore more likely to succeed if applied during this 'window of opportunity'. Better understanding of how commuters make mode use changes when triggered by life course events and for how long the process of change last is therefore important in the planning and implementation of TDM measures.

4.3. Research Questions

The following research questions were therefore set to help gain empirical knowledge on the process through which commuters go when changing their modes of transport as a result of the occurrence of a life course event.

- When are mode use choice habits broken in relation to the occurrence of a life course event?
- How long do commuters deliberate on mode use changes when triggered by life course events?
- Are the 'windows of opportunity' the same for different life course events?
- What are the information commuters seek and use in decision-making?

These were to give insight into the effect of life course events on mobility choices and how to better target commuters with TDM interventions.

4.4. Research Method

To be able to determine the influence of life course events on mode use choice, respondents were required to retrospectively recollect memories of when they last changed their mode of transport as a result of the occurrence of a life course event. Recall aids such as life course calendars were used to help trigger multiple memory recollection pathways. A deliberation calendar was then used to guide respondents in reporting on the process of habit breaking.

Data were captured into a spreadsheet database. They were analysed in both spreadsheet and NVivo – a qualitative analysis tool.

4.4.1. Survey Instrument Design and Data Collection

Commuters were required to remember the process they went through when they were changing their mode of transport after it was triggered by the occurrence of a life course event. A retrospective survey was therefore used in the collection of data. Survey tools used for the data collection included a questionnaire, life course event calendar and a deliberation calendar. The life course event calendar was used as a recalling aid for respondents.

4.4.1.1. Survey Questionnaire

A questionnaire schedule was designed to help guide interviewers in asking questions aimed at documenting the process a respondent go through in making a mode use change when they experienced a life course event (see appendix E). The questionnaire was structured based on how the three main types of memories – thus memories for extended events, summarised events and specific event – are stored and retrieved as argued by Belli (1998). Belli argued specific events and summarised events are nested in extended events. Remembering extended events such as life course events was therefore deemed to be useful in remembering the specific events such as when one changed their mode of transport, when they started looking for information, when they stopped looking for information, when they started thinking about mode use change and when they stopped thinking about it.

The questionnaire was therefore divided into four main sections. The first section asked questions about the respondents' demographic data and their current mode of transport. This was to get the respondent to start thinking about their means of travel and how they have travelled in the past. The second section was then aimed at helping respondents to remember and temporally reference the occurrences of life course events. The questions were therefore to guide interviewer in helping the respondent to complete an event history calendar. This included changes in employment, residence, co-habiting partnerships, children, acquisition of driver's license and private vehicle. The third section then narrowed in on the latest life course event in the respondent's life that triggered a change in mode use. The inter-connectivity of different life course events were tested here by asking the respondents

whether any other life course event had influenced the occurrence of the latest life course event in question. The last set of questions were aimed at helping respondents to remember in detail the process they went through when changing their mode of transport.

Respondents were given a brief description of the study and their consent sought before proceeding to the main sections of the questionnaire. They were assured of confidentiality of their data and given the opportunity to review their event history and deliberation calendars after they had been completed. Some socio-economic data such as gender, age and race were also collected.

4.4.1.2. Deliberation Calendar

The deliberation calendar was used to record the process a respondent went through in their mode use choice (see appendix F). This was to detail the process of habit breaking in terms of the duration for which respondents used in deliberating on mode use change and seeking information. This calendar was designed based on a mode use calendar. Two rows were added, one for recording the beginning and end of when commuters started seeking information and one for when they started and ended deliberating on mode use change. Respondents were assumed to be capable of providing detailed information about their mode use changes the closer it is to when the life course events occurred. A six months space was provided for such records on both sides of the event, with higher aggregations of time as one moves farther away from the event. This was to help record detailed variations in different attributes of travel choice such as departure times, route choice and mode use.

4.4.1.3. Sample Design and Selection

A structured interview was used in the collection of data. Interviews were to be household based due to the lengthy nature of the interview, as respondents were to recollect past travel behaviour. Getting individuals to open up their doors for the interview by showing up unannounced at their houses proved difficult. Respondents were therefore intercepted at public places such as shopping malls etc. The interview was then scheduled for a later time at their comfort. Respondents were assessed to see if they met the criteria for the interview at the interception point. Respondents were to be currently employed; with employment requiring at least three times a week travel to the same place of work. This was used as a proxy for the establishment of habits. Respondents were also required to have experienced either a change in job location, change in residence or acquired their first car within the past five years from

when the interview was done. These were the life course events that were observed to have dominated in mode use changes among commuters from the earlier mobility biography study on travel behaviour patterns. The cut off in year was to increase the probability of respondents remembering details of the event, as individuals were assumed to be more forgetful of details as the years between occurrence of the event and the date of recalling increases.

4.4.1.4. Data Collection

Data were collected through a structured interview with the help of a survey firm in May 2016. Field workers were sent out into the field after they were trained on administering the questionnaire. A pilot survey was carried out to test the response rate and the efficacy of the questionnaire. No major alterations were made to the questionnaire after the pilot survey. This was probably because of the mock interviews that were carried out before handing over the survey tools to the survey firm. Response rates were however low. Provision of incentives to respondents as a compensation for their time was thought of initially due to the lengthy nature of the questionnaire. This was later muted as it was agreed with the survey firm that it would be possible to get the target number of respondents without the use of incentives. Incentives may also have introduced sampling bias. The survey was therefore carried out without any compensation for time used by respondents.

After satisfying the pre-selection criteria, respondents were asked about their current travel patterns such as their mode of transport, the number of times they travel with that particular mode of transport, acquisition of a private vehicle and the main reason for the acquisition. The life course event history calendar was then completed with the help of the interviewer using the set of questions as a guide. Focus is then put on the occurrence of the latest life course event – among the three listed – that caused a change in mode use. Respondents were asked about the mode of transport they were using before and after the occurrence of the life course event. They were asked whether they had ever considered changing their mode of transport before the occurrence of the event and what prevented them from changing it, if they had thought of changing. The details in mode use change were then recorded. Respondents were asked about when they started thinking about how they travelled to work, when they started looking for information about alternative modes of transport, and when they stopped. All in relation to the occurrence of the life course event. Respondents were then asked whether they altered their departure times and route to work before and after changing their mode use. They were asked of the number of days or weeks for which they had varied their departure times and/or routes, if

they had varied them. They were asked whether they were satisfied after changing their departure times or route to work before changing their mode of transport and if they were satisfied with their travel patterns afterwards. They were then asked of the reason for which they did not stick to the previous mode of transport if they were satisfied.

Figure 4-2 shows an example of deliberation calendar of a 43 year old, male respondent who was using the train as a mode of transport to work at the time of the interview. Change in job location was reported as the influential life course event that caused him to change from using mini-bus taxi to using the train, a change in mode use in the same transport domain – public transport. He indicated deliberating on mode use change about three weeks before the occurrence of the life course event and started seeking information about two weeks before it. Deliberation and information seeking seized just after the mode use change was made, which was incidental with the occurrence of the life course event. He however experimented with departure time after changing to using the train. This was so as he had arrived at work earlier than usual when he first used the train to work.

Some satisficing and perception questions were then asked of respondents. They were asked if they were able to gather all available information they thought was there about the different modes of transport they were considering and whether they were satisfied with the amount of information they had gathered in their decision making process. They were then asked about their perception about the mode of transport they were changing to, before and after using them.

They were also asked about some of the information they sought after, during their decision making process. The interview was then concluded with some attitudinal questions. Respondents were asked whether the reality of using a mode of transport was different from what they thought it would be. Questions included; whether they found it easier searching for information than they thought; whether traveling time were shorter than they thought; whether the cost of using the mode of transport was cheaper than they thought; whether they and the society think highly of people who use the mode of transport; and whether they were influenced by what others think of the mode of transport. These questions were to find out whether respondent's attitude towards a mode of transport had changed as a result of their experiences with using that particular mode as proposed by Bem (1972) in advancing the self-perception theory.

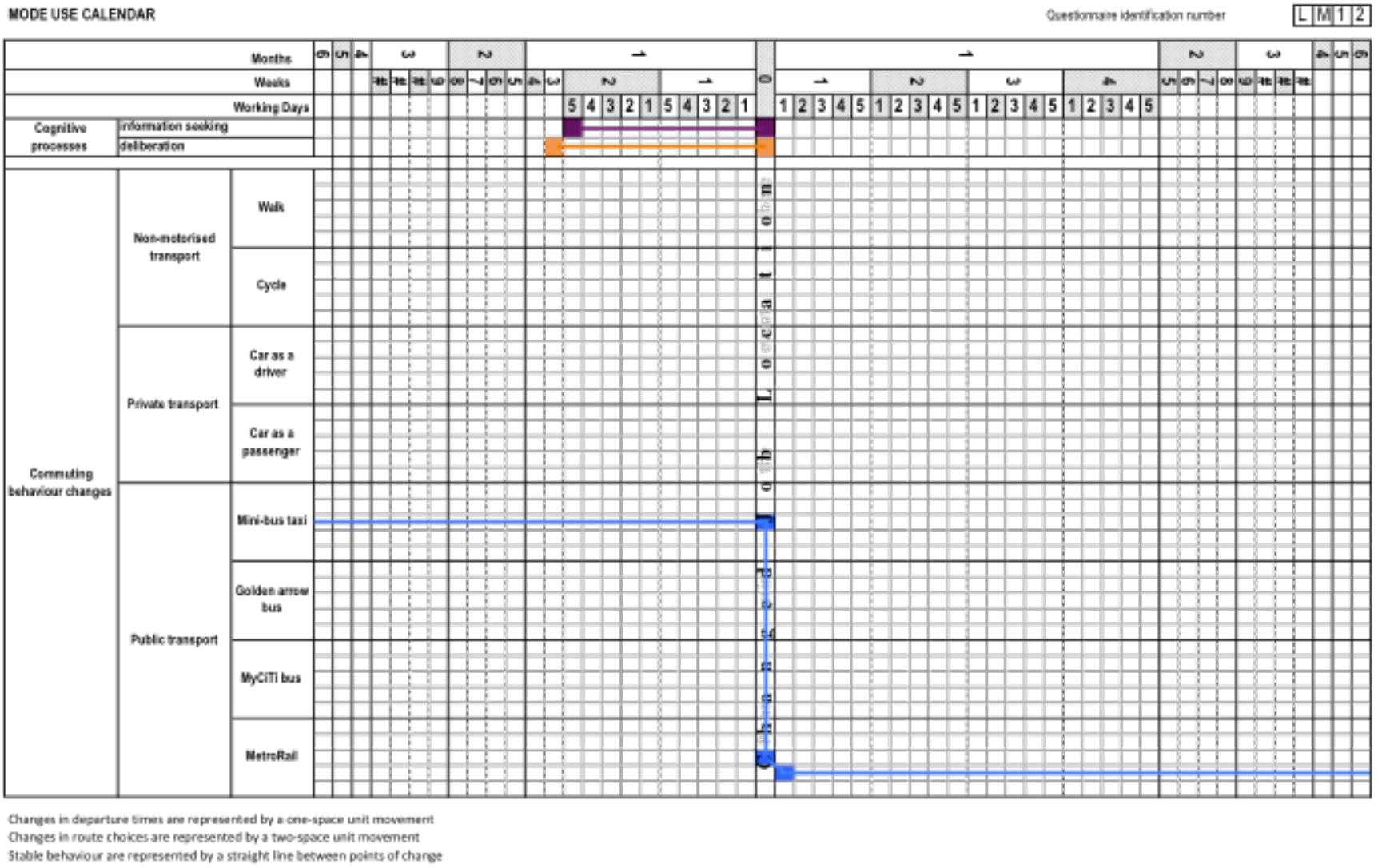


Figure 4-2: Example of a deliberation calendar (a 43 year old, male respondent)

4.4.2. Analysis

The collected data were entered into a Microsoft Excel worksheet for analysis. Notably captured data included when respondents started deliberating on their mode use and when they stopped; when they started looking for information about alternative modes of transport and when they stopped. These were analysed to determine when commuters are most likely to be susceptible to mode use changes, thus determining the 'window of opportunity' for which TDM measures can be applied. Also analysed was how interconnected life course events were. This was to see if the occurrence of a life course event could be predicted from the occurrence of another.

The data was also analysed to see if respondents were more loss-averse – as argued by Kahneman and Tversky (1979) in their advancement of the prospect theory – or not when changing mode. Things they thought they would gain or lose by changing to a mode of transport was analysed using NVivo – a qualitative data analysis software. The word cloud tool in NVivo was used to evaluate the key words that respondents used when they were asked open-ended questions such as what they thought they would lose or gain after a mode use change was made.

A word cloud is a visual representation of keywords used by respondents in answering an open-ended question. It shows the most frequently used words by the respondents. The frequency with which keywords are used is represented by the size the word appears. The more frequent a word is used by the respondents, the larger it appears in size in the word cloud visualization. This is useful as it helps in determining themes in open-ended responses.

4.5. Results

4.5.1. Descriptive Analysis

The targeted number of 250 completed surveys was achieved at the end of the survey. This number was reached after contacting a total of 1571 individuals. This resulted in a gross response rate of about 15.9%. Not all of individuals contacted were however, eligible for the survey due to the pre-selection questions. The number of eligible individuals contacted – thus the number of individuals not willing to participate and the number of completed respondents – amounted to 775 individuals. The effective response rate for the survey was therefore 32.3% (Table 4-1). More than half – about 59% – of the individuals unwilling to participate in the survey indicated the lengthy nature of the survey as a reason for their refusal. The rest provided no reason.

A gender split of 46:54 percentage was observed among the 250 respondents (Table 4-2). The majority of respondents, representing about 49% were of the black descent. This was followed by respondents of the coloured, white and Indian descent, representing about 37%, 12% and 2% respectively. The respondents were wide spread in terms of age; with the minimum age being 18 years and the maximum age being 71 years (Figure 4-3). The mean age was observed to be 35.6 with more than half (about 58%) of the respondents falling below the age of 35 years. These respondents were observed to be residing mainly in the Cape Flats, Southern Suburbs and Northern Suburbs. Very few respondents were residing in Helderberg and West Coast (Figure 4-4).

All respondents were employed at the time of the survey, requiring at least 3 times per week travel to the same place of work and having experienced a change in mode use to work as a result of the occurrence of either a change in job location, residence or acquisition of their first car within the last 5 years from the time of the survey. These were made possible through the selection questions to which respondents were to answer 'yes' to all, before being eligible for the survey. Results are thus not representative of the general population, but representative of the population experiencing these life course events.

Table 4-1: Reasons for non-response

	Race			
Reason	**Black**	**Coloured**	**White**	**Total**
Did not qualify – not employed	171	114	45	**330**
Did not qualify – does not go to same place of work	117	74	20	**211**
Did not qualify – did not change mode of transport	154	65	36	**255**
Not willing to participate – too long	108	89	111	**308**
Not willing to participate – reason unknown	111	75	31	**217**
Total	**243**	**417**	**243**	**1321**

Table 4-2: Demographic characteristics among respondents

		Respondent Race				
		Black	**Coloured**	**White**	**Indian**	**Total**
Respondent gender	**Male**	61	37	15	3	**116**
	Female	62	56	15	1	**134**
Total		**123**	**93**	**30**	**4**	**250**

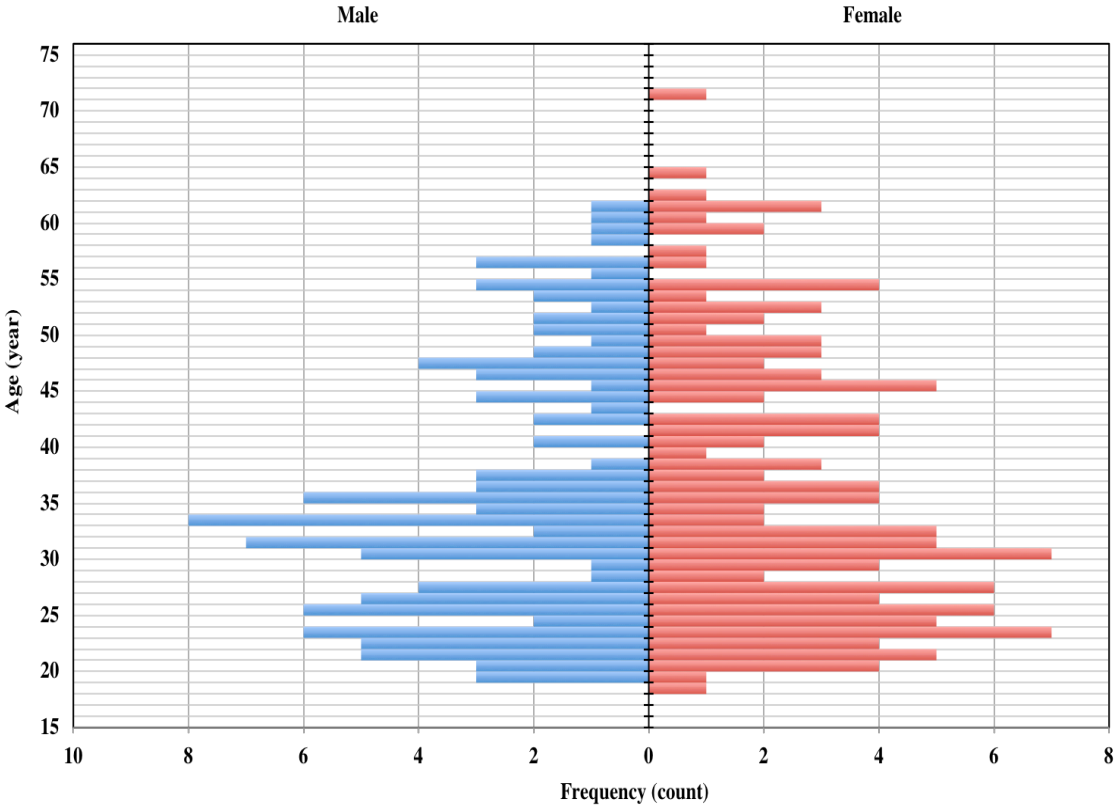


Figure 4-3: Age pyramid among respondents

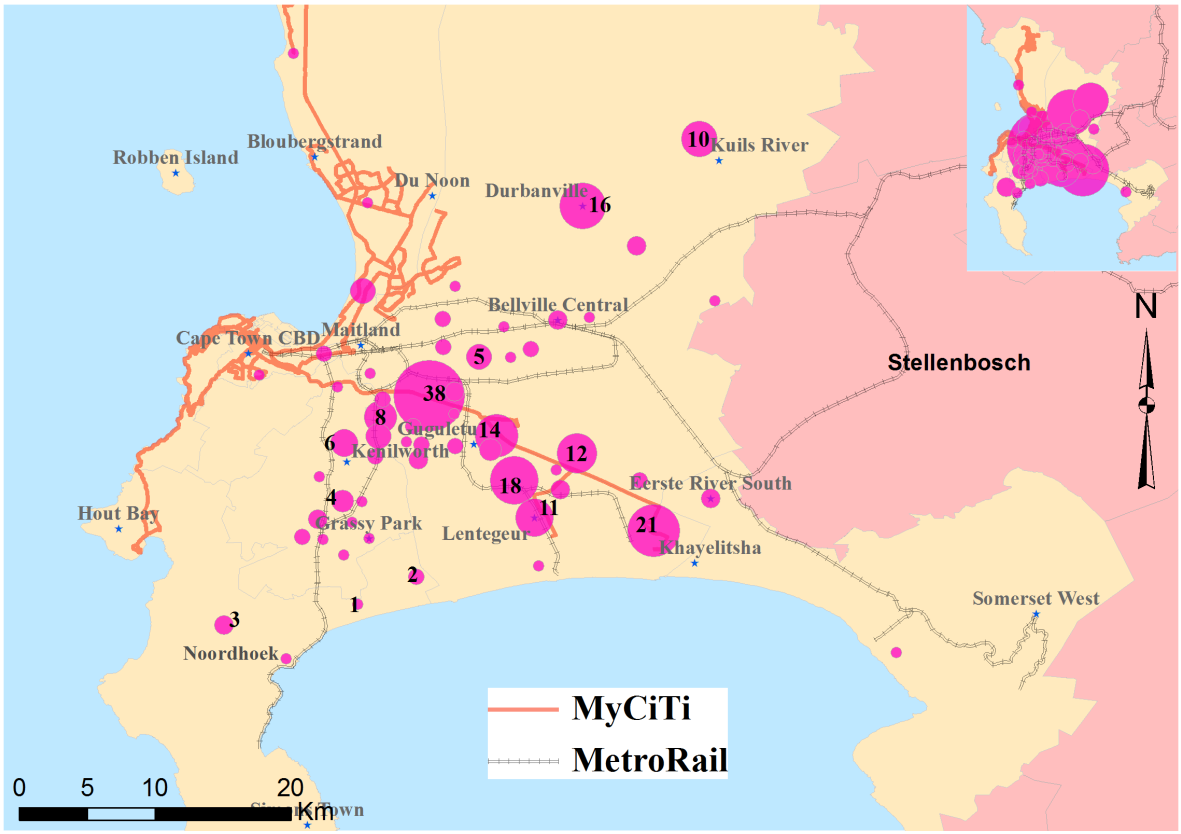


Figure 4-4: Spatial distribution of respondents' residential neighbourhoods

4.5.2. Mode Use Changes Among Respondents

The mini-bus taxi was the most used mode of transport among the respondents, representing about 31% (Table 4-3). The car as a driver followed, with about 26% of the respondents driving their cars to work. A combination of car as driver and as a passenger – that is car use – was however higher than that of mini-bus taxi use. The two resulted in a mode use of about 35% among respondents. This was lower than the mode use for car of 50% from the City of Cape Town's household travel diary survey (Adjei, Behrens *et al.* 2014). Only one respondent reported walking to his current mode of transport.

Most of the respondents (about 95%) reported traveling to their work places every working day with the same mode of transport over the last 3 months from the time of the survey. Just a few respondents, representing about 5%, reported travelling four and three times to work with their most used mode. Mode use was therefore observed to be largely habitual among respondents. This was in line with the assertion from the first mobility biography survey and other literature.

Table 4-3: Frequency of mode use

		Number of days used in a working week			
		Three	Four	Five	Total
Mode of transport current used by Respondents	Mini-Bus Taxi	3	1	73	77
	Car as a Driver	0	1	64	65
	MetroRail	0	0	45	45
	Golden Arrow Bus	2	3	30	35
	Car as a Passenger	1	0	21	22
	MyCiTi Bus	1	0	4	5
	Walk	0	0	1	1
Total		7	5	238	250

The habitual nature of mode use was also exhibited when respondents were asked if they had ever considered changing their mode of transport before the occurrence of either of the three-life course events. The majority – thus about 75% – of the respondents indicated not considering changing their mode use before the event (Figure 4-5). This was likely to be so as respondents may have entered into a habitual pattern and were not deliberating on their mode use choices on daily basis. Some of the reasons to which the 25% of respondent who thought about changing but could not change their mode

included; affordability, accessibility, convenience, limited information *etc.* as can be seen from some of their responses below.

> *"Thought about it [changing mode] but could not finance a car" (a 35 year old female respondent who changed from mini-bus taxi to car-as-a-driver use after purchasing first car)*

> *"Mini-bus taxi was the only mode of transport on that route at the time I worked there, and no bus on that route" (a 36 year old female respondent who changed from mini-bus taxi to Golden Arrow Bus use after changing job location)*

> *"The bus was the only viable mode at that time where I live" (a 24 year old female respondent who changed from Golden Arrow Bus to mini-bus taxi use after changing residence)*

> *"Thought about it [changing mode] but rail was the most affordable option at the time" (a 31 year old male respondent who changed from train to mini-bus taxi use after changing job location)*

> *"Public transport was accessible and more affordable" (a 32 year old female respondent who changed from Golden Arrow Bus to car-as-a-driver after changing job location)*

> *"Was new in town at the time and did not know all the modes" (a 35 year old male respondent who changed from mini-bus taxi to train use after changing job location)*

An even larger percentage of respondents (about 95%) indicated never thinking of changing their mode after they had settled on a new one – a change that was triggered by the occurrence of a life course event (Figure 4-5). About 13% of the respondents indicated trying to change their departure time with the previous mode before changing. A smaller percentage of respondents (about 2%) indicated changing route to work with their previous mode of transport before changing it. Among the respondents indicating changing their departure times, about 52% indicated their satisfaction with their travel patterns afterwards. They however moved on to change their mode and some of the reasons can be found in examples of their comments below;

"Two days after starting in my new job, my work arranged to give me a lift which dropped me at home" (a 32 year old female respondent who changed from mini-bus taxi to car-as-a-passenger after changing job location).

"It [current mode] is more cheaper than my previous mode of transport" (a 33 year old female respondent who changed from mini-bus taxi to train after changing job location)

The majority – about 85% – of the respondents indicated a straight choice and movement from their previous mode to the new without experimenting with different modes. Respondents' mode use choice may have being influenced by their past experiences with certain modes of transport – a proxy for habit. They may, therefore, have changed to a mode of transport they were familiar with. Respondents may also have chosen modes they were familiar with to avoid uncertainties with other modes of transport they were not familiar with – an element of loss aversion as postulated in Kahneman and Tversky's (1979) prospect theory. Respondents may also have decided on their mode of transport in anticipation of the occurrence of a life course event. The remaining 15%, however indicated trying out different modes before settling on one.

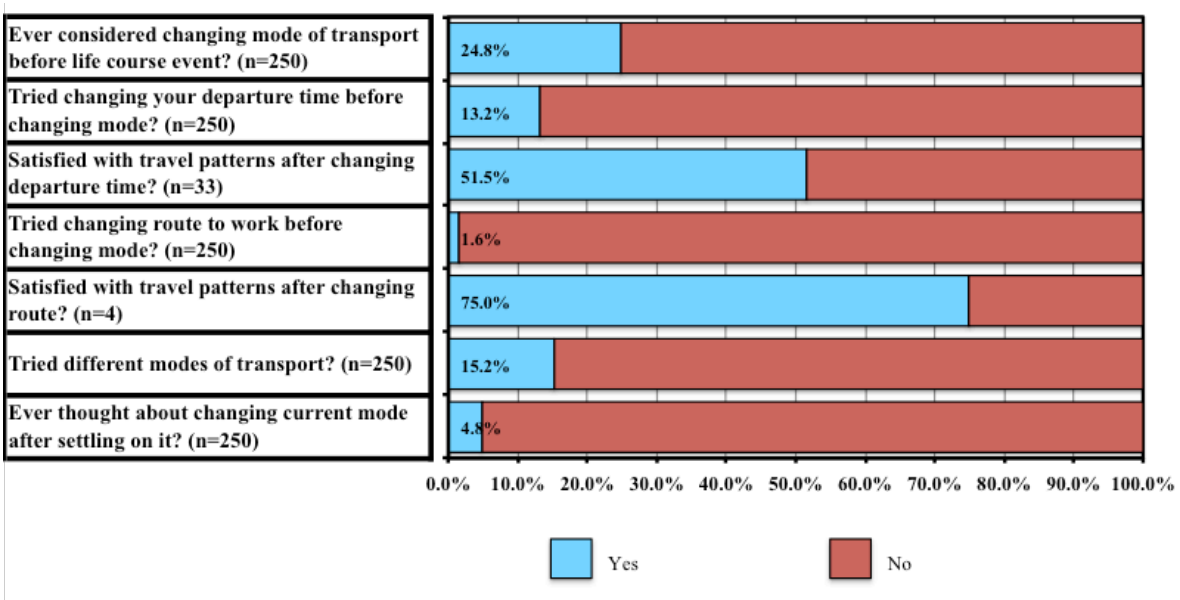


Figure 4-5: Variabilities in travel choices before and after the occurrence of a life course event

Reasons for the acquisition of private vehicle

From the 250 respondents received, 99 of them – representing about 40% – reported having bought or been given the use of a car before. Some of the notable words appearing from analysis of their reason behind the acquisition of the car included; work, transport, travel, convenience, comfort, safety/safe/unsafe, quicker, delays *etc* (Figure 4-6). Words such as work, transport and travel were expected as the survey was targeted at commuters. Some of these thoughts can be found in examples below.

Some respondents thought public transport were unreliable, unsafe to use, hence their decision to acquire a car. The unreliability issues included travel delays and difficulties in getting public transport at certain times of the day.

> *"I felt like having my own car because trains are delayed all the time" (a 60 year old male respondent)*

> "*It [car] is more safe and secured and sometimes the trains are delayed" (a 35 year old male respondent)*

> *"I work late and can't use public transport after 8pm, it is not safe" (a 40 year old female respondent)*

> *"Public transport is unsafe in the sense, that is why I have changed" (a 28 year old male respondent)*

Some also gave the flexibility, convenience and comfort with which private cars offer as their main reason for the acquisition of a personal car.

> *"It is good to have your own car because it is more convenient" (a 35 year old male respondent)*

> *"I just felt like having my own car because it is more convenient and I get to work on time" (a 31 year old male respondent)*

"Comfort, convenience, security and timeously arriving at work" (a 35 year old male respondent)

"For personal use (every month when I bought groceries, it was an uphill battle travelling). Now that I own my own car it is so much easier and for work" (a 41 year old female respondent)

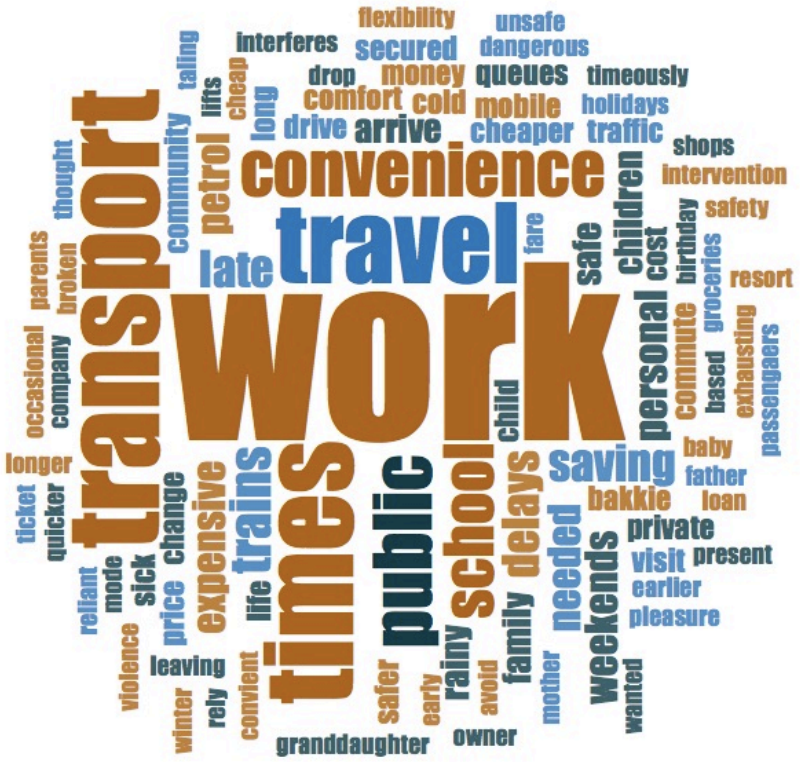


Figure 4-6: Word cloud: Main reason for acquisition of private transport

Life course events

Apart from the acquisition of a car, changes in job location and residences were also found to be the other two most dominating life course events that caused changes in mode use from the previous study. They were therefore chosen for the current study. Only the most recent event that caused changes in mode use were investigated. From the analysis, changes in job location was observed to be the most dominant life course event among the respondents – with 145 (representing about 58%) of respondents reporting it to be the most recent event that caused them to change their mode of transport (Table 4-4). Changes in residence location caused mode use changes among 58 (representing about

23%) of respondents with 47 (representing about 19%) of the respondents reporting buying their first vehicle as the most recent event. This was in line with the first survey where changes in employment were observed to be the dominant life course event causing mode use changes.

Buying a first car always led to change to the use of a car as a driver. Changes in residence and job location, however, led to changes to all the various mode of transports.

Table 4-4: Latest life course events and modes of transport respondents changed to, n=250

		Mode of transport that respondents changed to after the occurrence of life course event (%)							
		Walk	Metro Rail	MyCiTi Bus	Golden Arrow Bus	Mini-bus taxi	Car as a passenger	Car as a driver	Total
Latest life event	Bought first car	0	0	0	0	0	0	47	**47**
	Changed residence	1	11	2	9	20	7	8	**58**
	Changed job location	0	31	3	28	57	13	13	**145**
Total		**1**	**42**	**5**	**37**	**77**	**20**	**68**	**250**

The occurrences of these life events are sometimes interconnected, thus the occurrence of one can trigger the other. About 17% of respondents reported the occurrence of their latest event that caused them to change their mode use as being influenced by other life course events. Changes in residence were reported as the most influential life course event for a change in job location, accounting for about 45% of the changes (Table 4-5). The most telling events when it came to change in residence were changes in job location (about 47%) and co-habiting (about 41%). New child (about 40%), driver's license (about 30%) and a new job (about 20%) were also reported to influence buying of first car (Table 4-5). These influencing life course events may have occurred either before or after the latest life course event that caused mode use changes. For example, changes in residence may result in longer distance between trip origin and destination, prompting an individual to start searching for new employment closer to their residence. This can also happen in the reverse, where changes in job location can prompt an individual to search for a residence closer to their job location.

Table 4-5: The interconnectivity of life course event occurrence (percentage, n=47)

Influencing events / Latest event	Job location	Residence	Co-habiting	New Child	First Car	Driver's License	Total
Bought first car	20	10	0	40	0	30	100
Changed residence	47	0	41	6	0	6	100
Changed job location	0	45	0	10	25	20	100

Information gathering was thought of to be important in the decision-making process of a mode use change. This happens when habit is broken and deliberation induced. In an attempt to be rational, an individual may seek to collect all information about the different alternatives. Rationality is however, bounded by the amount of information collected, which is rarely the complete set of information as argued by Simon (1957) in the bounded rationality theory. In line with this, respondents were asked whether they were able to gather all available information they thought there was about the various modes of transport they were considering and as to whether or not they were satisfied with the amount of information gathered. A large part of respondents – 191, representing about 76% - indicated being able to gather all available information they thought there was (Figure 4-7). This reflected in the high level of satisfaction about the amount of information gathered, with 196 respondents – representing 78.4%. Majority of respondents – 46, out of 54 - who indicated not being able to gather all available information they thought there was, however, indicated their dissatisfaction about the amount of information gathered (Table 4-6).

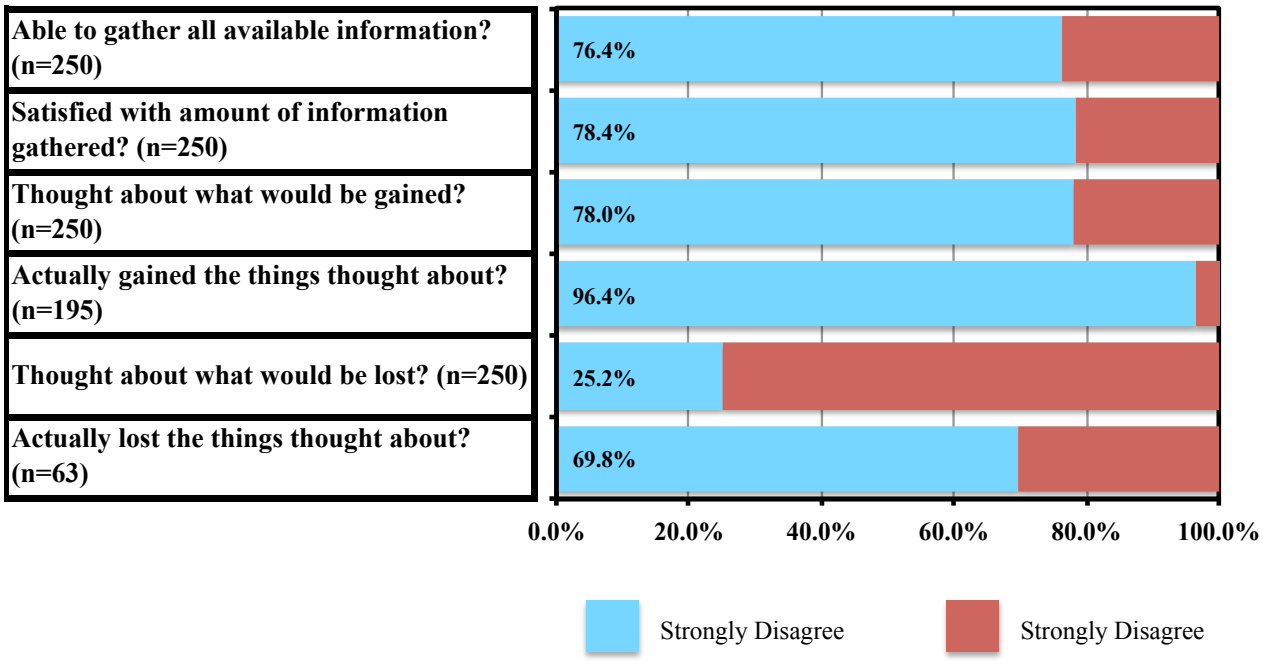


Figure 4-7: Information gathering among respondents

Table 4-6: Satisfaction about amount of information gathered

		Satisfied?		
		Yes	No	Total
Able to gather all information thought there was?	Yes	183	8	191
	No	13	46	59
Total		196	54	250

Respondents were observed to think more about what they would gain by changing to a mode of transport than what they would lose (Figure 4-7). Out of the 195 respondents who thought about what they would gain, 188 of them – representing about 96% - indicated actually gaining what they thought they would gain. The things respondents who were changing to private vehicle use thought they would gain included; safety, comfort, convenience, shorter travel times, independence, *etc* (Figure 4-8). Respondents changing to public transport use, on the other hand thought they would gain among others, savings on transport fares, travel times, convenience, *etc*.

Fewer respondents – 63, representing 25.2% - reported thinking about what they would lose by changing their mode of transport (Figure 4-7). Out of the 63 respondents, 44 reported actually losing what they thought they would lose. Affordability, money, cost, *etc* were some of the prominent words

appearing when respondents changing to private vehicle use were asked what they thought they would lose (Figure 4-9). Respondents changing to public transport use, had words like comfort, convenience, safety, freedom, *etc.*

(a) Private transport (b) Public transport

Figure 4-8: Word Cloud: Things respondents thought they would gain by changing to either private or public transport

(a) Private transport (b) Public transport

Figure 4-9: Word Cloud: Things respondents thought they would lose by changing to either private or public transport

Operational cost (which included fares in terms of public transport and fuel for private transport), travel time, comfort, convenience of mode use, safety and security, environmental impacts and health issues were some of the information respondents were asked if they had considered during their deliberation on mode use changes. No significant differences were observed for the answers given to most of the statements by respondents who had changed to private transport and those who had

changed to public transport after the occurrence of the life course event. The only exceptions were comfort; and safety and security, where more respondents changing to public transport use indicated not considering them (Figure 4-10). Most respondents indicated factoring in operational cost, travel time, comfort, convenience, safety and security. However, fewer respondents indicated considering environmental impacts (about 26% and 29% for private and public transport users respectively) and health (about 59% and 60% for private and public transport users respectively) in the decision making process.

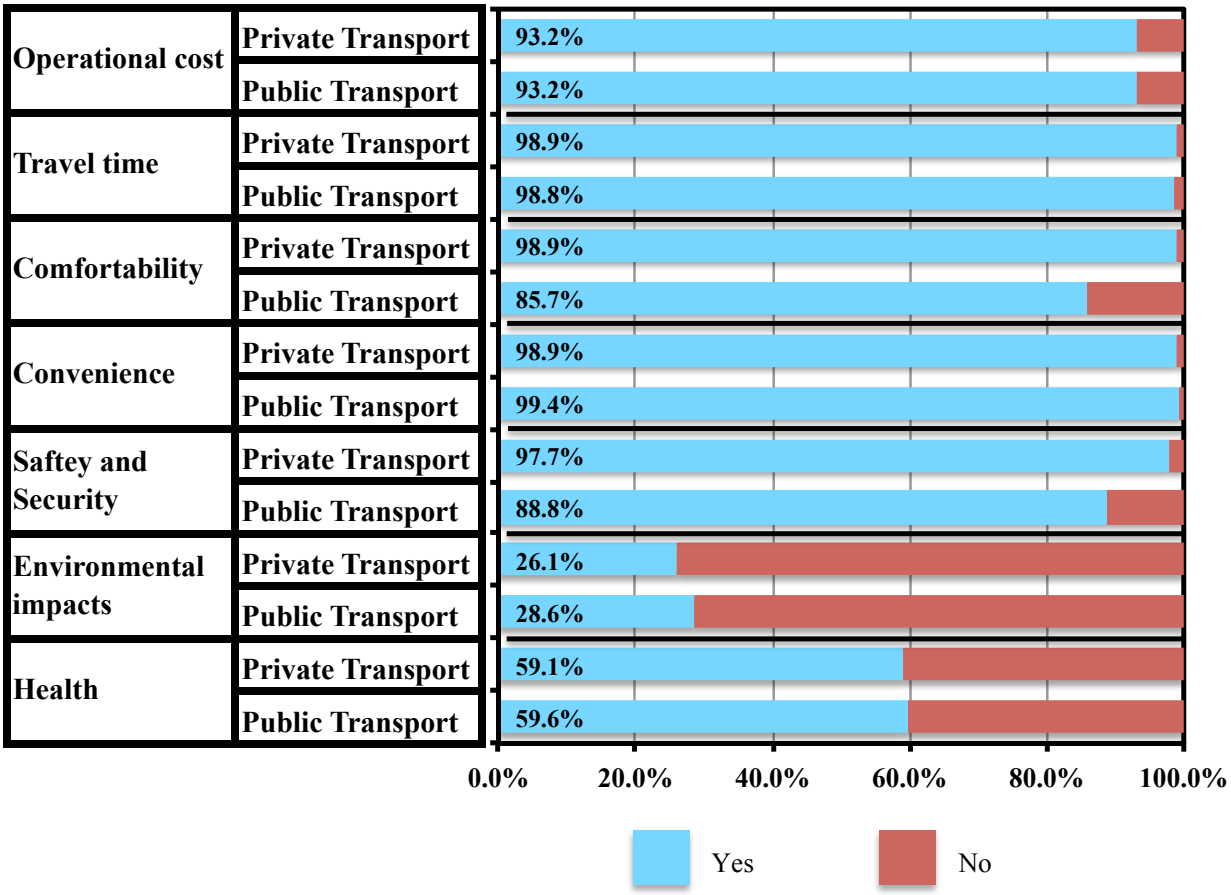


Figure 4-10: Information considered during decision-making process

The point at which respondents started deliberating on changing their mode of transport and thus started searching for information was investigated. These were used as indicators for when respondents' levels of awareness for change increased, resulting in habit breaking. This time periods varied among respondents. It varied from 1 to 121 working days before the occurrence of the life course event and from 0 to 100 working days after the event to deliberate (Table 4-7). Respondents took between 1 to 121 working days before life course event and 0 to 55 working days after it to seek

for information on the various modes. On average it took respondents about 30 working days before the occurrence of the event and 1 working day after the occurrence of the life course event to deliberate on mode use changes. It took about 24 working days before the life course event for respondents to start seeking information and less than a working day after the event for them to stop seeking information needed for deliberation. The window of opportunity was observed to be about 31 working days, thus about 31 working days for deliberation and 25 working days for information seeking.

The 'windows of opportunity' for respondents who were changing to the various modes of transport after experiencing a life course event were compared to reveal any similarities or variabilities between them (Table 4-7). Respondents changing to Golden Arrow bus were observed to take the most number of working days in deliberating on their mode use changes, taking about 45 working days on average. All of these days were observed to be before the occurrence of the life course event as the average number of days for deliberation and seeking information for respondent changing to Golden Arrow bus after the occurrence of the event was observed to be zero. The fewer number of days used in deliberation and searching for information after the event were also observed among respondents who changed mode use to other public transport, with respondents changing to MetroRail, MyCiTi and Mini-bus taxi all taking less than a day. This may be attributed to the fact that respondents did not have control over the departure times and route choice of these modes. The 'windows of opportunity' were observed to be about 23, 31 and 25 working days for MetroRail, MyCiTi and Mini-bus taxis respectively. Respondents who changed to car as a passenger were also observed not to deliberate much after occurrence of the life course event, taking less than a day. This may also be attributed to the lack of control over departure times and routes. Respondents changing to car-as-a driver were observed to take about 38 working days to deliberate and 37 working days to seek for information. They spent more days (about 3 working days) compared to the others to deliberate on their choice after the occurrence of the event. These were mostly deliberation on departure times and route choices in order to arrive at their work places at the right time.

Mode of transport respondents changed to		Period before life course		Period after life course event		Window of opportunity	
		Deliberation	Information seeking	Deliberation	Information seeking	Deliberation	Information seeking
Metro Rail	N	32	32	32	32	32	32
	Mean	21.5	13.3	0.7	0.7	22.2	14.0
	Minimum	1	1	0	0	1	1
	Maximum	121	81	3	3	121	81
MyCiTi Bus	N	5	5	5	5	5	5
	Mean	30.6	31.0	0.4	0.4	31.0	31.4
	Minimum	1	1	0	0	1	1
	Maximum	121	121	1	1	121	121
Golden Arrow Bus	N	27	27	27	27	27	27
	Mean	44.5	36.2	0.0	0.0	44.6	36.3
	Minimum	1	1	0	0	1	1
	Maximum	121	121	1	1	122	122
Mini-Bus Taxi	N	54	54	54	54	54	54
	Mean	24.6	15.3	0.4	0.4	25.0	15.7
	Minimum	1	1	0	0	1	1
	Maximum	121	121	4	4	121	121
Car as a Passenger	N	14	14	14	14	14	14
	Mean	21.8	21.9	0.1	0.1	21.9	22.0
	Minimum	1	1	0	0	1	1
	Maximum	121	121	2	2	121	121
Car as a Driver	N	48	52	49	52	49	52
	Mean	36.0	33.8	2.8	1.8	38.0	35.6
	Minimum	2	2	0	0	2	2
	Maximum	121	121	100	55	123	176
Total	**N**	**180**	**184**	**181**	**184**	**181**	**184**
	Mean	**30.0**	**24.2**	**1.0**	**0.8**	**30.9**	**25.0**
	Minimum	**1**	**1**	**0**	**0**	**1**	**1**
	Maximum	**121**	**121**	**100**	**55**	**123**	**176**

Table 4-7: Window of opportunity among respondents using different mode of transport (days)

The data was also analysed to explore any variations or similarities among respondents experiencing different life course events in terms of the time they use in deliberating on mode use change. There was no significant difference in the number of working days that respondents who bought their first car took in deliberating and seeking information and that of those who changed their residences (Figure 4-11 and Figure 4-12). On average, it took respondents buying their first car 39 and 33 working days to deliberate on a change in mode of transport and search for information respectively, while it took respondents changing residence 40 and 33 working days. Respondents changing their job location however took a bit less time in considering changes in mode use, thus 25 working days for deliberation and 20 working days for information seeking (Figure 4-13). The window of opportunity for respondents changing job location was therefore shorter than those for respondents acquiring their first car and changing residence.

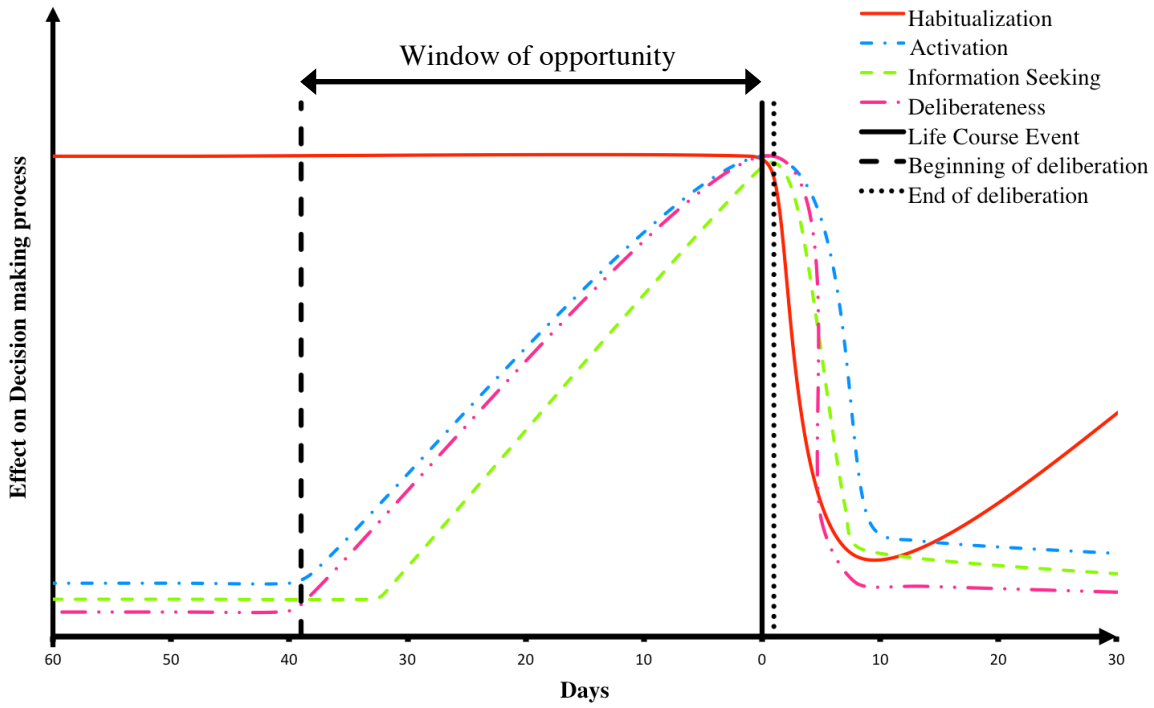


Figure 4-11: Window of opportunity for respondents that acquired their first car

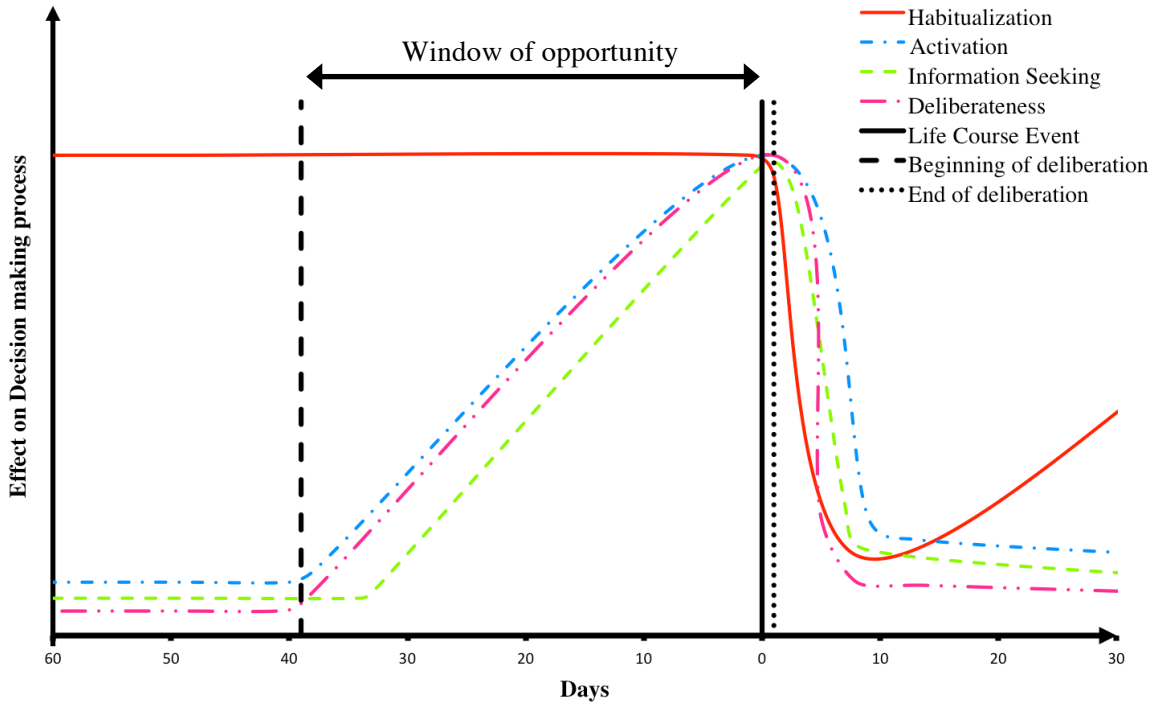


Figure 4-12: Window of opportunity for respondents that changed residence

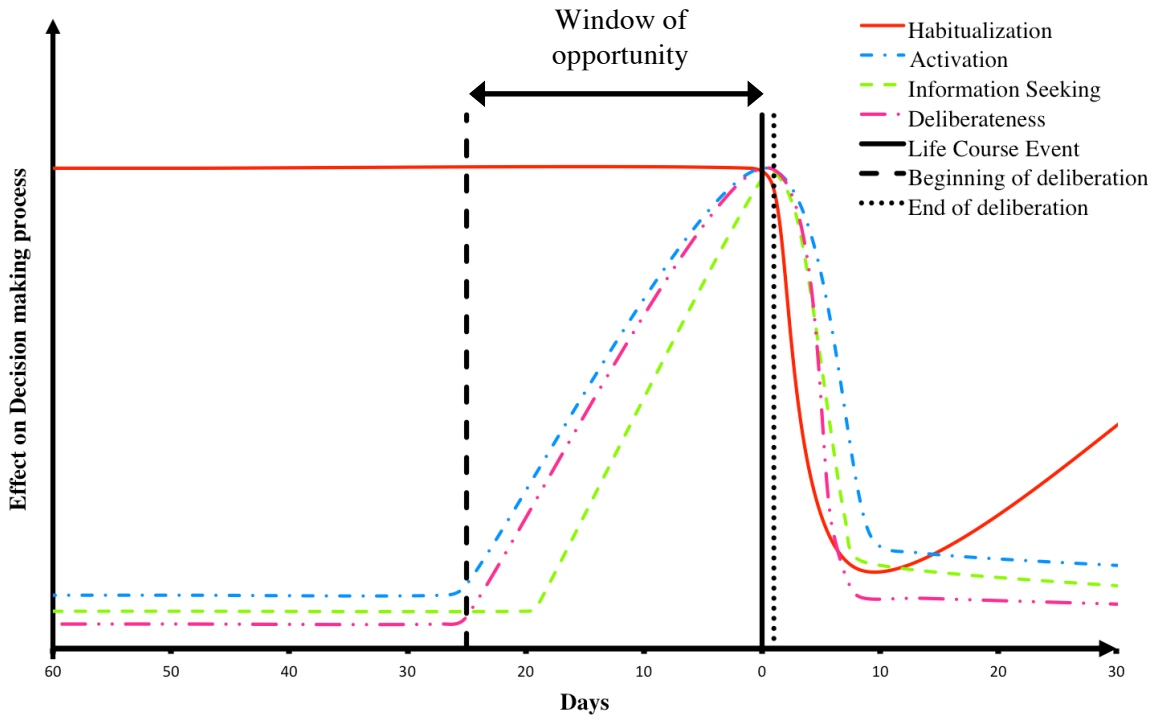


Figure 4-13: Window of opportunity for respondents that changed job location

4.5.3. Attitude Towards Mode Use and Mode Use Change

In general, respondents – 235, representing 94% - reported having a better experience about the mode of transport they changed to than they expected (Table 4-8). This better experience was reported across all the different modes of transport respondent changed to after the life course event.

Table 4-8: Experience about mode use

		Experience about mode		
		Better	Worse	Total
Mode use after the life course event	Car as Driver	63	5	68
	Car as Passenger	19	1	20
	Mini-bus Taxi	70	7	77
	Golden Arrow Bus	35	2	37
	MyCiTi Bus	5	0	5
	Metro Rail	42	0	42
	Walk	1	0	1
Total		235	15	250

Comfort, convenience, shorter travelling times, safety were some of the prominent words when respondents who changed to private transport use were asked of their general thoughts about it before changing to its use (Figure 4-14). Convenience, comfort, cheaper, unreliable, dangerous, safety; were some of the prominent words when it came to respondents who changed to public transport use (Figure 4-14). These words were similar when it came to the thoughts of respondents after they had used the various modes of transport (Figure 4-15). The words were, however, used in different contexts as illustrated in examples of responses below. The first lines represent the thought of respondents about the mode of transport before they used it while the in-step second lines represent their thought after they had used it for the first time.

These are some of the responses given by respondents who changed from public transport to private transport use.

"That it would be more convenient"

↳ *"It was more convenient"*

(a 35 year old male respondent who changed from metro rail to car as a driver)

"I thought it would be cheaper"

↳ *"I get to work on time and they pick me up at home but travel fare is too much"*

(a 35 year old male respondent who changed from mini-bus taxi to car as a passenger)

"It would be cheaper and convenient"

↳ *"It is expensive and not safe"*

(a 42 year old male respondent who changed from metro rail to car as a driver)

"It is convenient to take you from point A to point B"

↳ *"It is sometimes unreliable, breaks [down] at the most impossible times. It must always have petrol, which means I must always have money (which I don't always have)"*

(a 41 year old female respondent who changed from mini-bus taxi to car as a driver)

"It would be convenient"

↳ *"It is convenient but also costly"*

(a 27 year old female respondent who changed from mini-bus taxi to car as a driver)

The following are some examples of responses provided by respondents who changed from private transport to public transport use or from one public transport to another.

"Spacious and convenient"

↳ *"Travelling time is shorter than I thought"*

(a 44 year old female respondent who changed Golden Arrow bus to MyCiTi bus)

"It is not safe, but it is cheaper and is my only way of getting to work on time"

↳ *"It is alright once you get used to it, but safety comes first"*

(a 19 year old male respondent who changed from Golden Arrow bus to mini-bus taxi)

"Mini-bus taxis are dangerous and they drive carelessly"

↳ *"Not all drivers are careless and it is cost effective"*

(a 27 year old female respondent who changed from Metro rail to mini-bus taxi)

"It stops too much and I will be late for work"

↳ *"It is cheaper and although it stops at certain points, I get to work on time"*

(a 56 year old female respondent who changed from mini-bus taxi to Golden Arrow bus)

"Scary, unsafe, unhygienic"

↳ *"Very reliable, safe"*

(a 22 year old male respondent who changed from car as a driver to Golden Arrow bus)

"Safety and travelling time"

↳ *"It is not that bad, I am always on time for work"*

(a 30 year old female respondent who changed from mini-bus taxi to Metro rail)

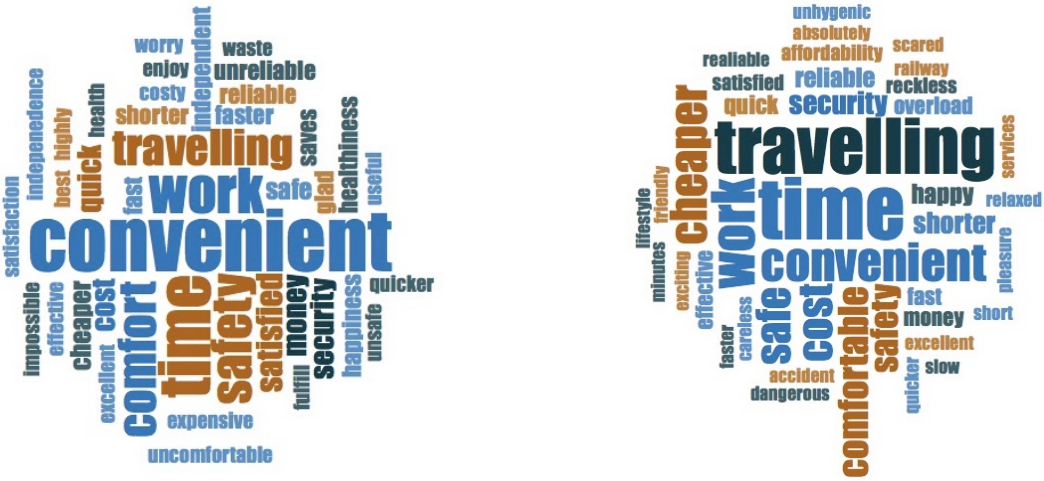
"Cost of travelling to work is cheaper than other mode of transport"

↳ *"Travel time is shorter because [there are] no robots [traffic lights] on trains"*

(a 33 year old male respondent who changed from car as a driver to Metro rail)

(a) Private transport (b) Public transport

Figure 4-14: Word Cloud: Thoughts about mode of transport before using them



(a) Private thoughts after (b) Public thoughts after

Figure 4-15: Word Cloud: Thoughts about mode of transport after using them

Respondents changing to private transport use were generally positive towards the mode before and after using them. This was not so in the case of public transport, where they were generally negative before they ever used it. Respondents' attitude toward the public transport – at least, as observed from their thoughts about them after they had used the mode – improved. These were also observed in respondents' answers when asked to strongly disagree, disagree, agree and strongly agree to series of statements about mode use. They also had the option of staying undecided or choosing when they did not know. A diverging stack bar chart was used to present the results (Figure 4-16).

The horizontal scale represents the percentage of respondents giving a particular answer while the vertical scale represents the different statements made. Respondents who responded as 'do not know' were separated into a different bar chart and presented alongside the stacked bar chart. Among the respondents, 161 indicated having changed to public transport after the life event, with 88 indicating changes to private transport. The remaining respondent changed to walk as the mode of transport to work. Most of the respondents agreed or strongly agreed to the easiness in finding information (about 76% for public transport users and 75% for private transport users) and travelling time being shorter (about 86% for public transport users and 90% for private transport users) than they thought it would be. Most respondents, 28 representing about 31% of individuals who changed to private transport reported 'undecided' when asked whether the cost of travelling to work was cheaper than they thought it would be. Very few respondents strongly agree or disagree with this statement. Contrary to what was

observed with respondents who changed to private transport, most of the respondents, 98 representing about 61% of individuals who changed to public transport agreed or strongly agreed to finding the cost of travelling to work cheaper than they thought it would be. The higher percentages observed among respondents changing to private transport to stay 'undecided' about the cost of travelling may have been due to their attempt at averting loss – an assertion by Kahneman and Tversky's (1979) prospect theory.

Responses were nearly evenly distributed when respondents who used public transport to travel to work were asked whether they thought highly of people who use the mode. About 38% of the respondents strongly disagreed or disagreed to the statement, with about 30% agreeing or strongly agreeing to it. A significant number of them – about 19% – were undecided, with about 13% of them indicating that they 'did not know' how they thought about people who use public transport. This leads to the formation of subjective norms which has been argued to influence behaviour in theories like Ajzen's (1985) theory of planned behaviour and Triandis' (1977) theory of interpersonal behaviour. The near even distribution of responses among respondents who changed to public transport was not the same among respondents who changed to private transport. About 38% of this section of respondents agreed or strongly agreed to the statement, with about 28% of them disagreeing or strongly disagreeing. Once again a significant percentage of them – about 18% - were undecided, with about 16% indicating not knowing how they think about people using private transport.

Responses to the question of whether others think highly about people who use the mode of transport recorded the highest respondents indicating 'I do not know', with about 38% and 23% of respondents who changed to public and private transport respectively. A significant percentage of respondents (about 18% and 24% for those who changed to public and private transport respectively) were 'undecided'. Respondents who changed to public transport – about 34% - were more in disagreement to the statement than those who changed to private transport – about 24%. Thus respondents who used public transport did not think other people in the society thought highly of them. In spite of these negativities, the majority of respondents in both categories – 55% and 57% for respondents who changed to public and private transport respectively – did not allow themselves to be influenced by what others thought about their mode use choice.

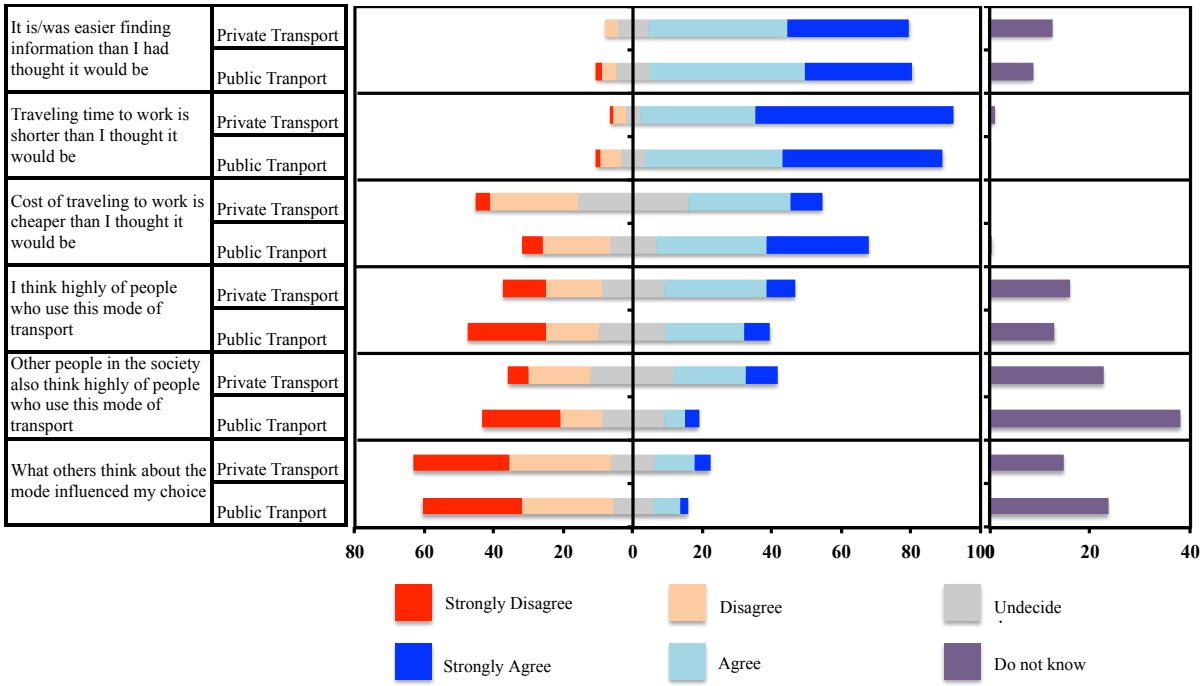


Figure 4-16: Attitude toward private and public transport

4.6. Discussion

4.6.1. The Process of Breaking Mode Use Choice Habits

Mode use choice has been observed as the most habitual attribute of a trip decision. Thus, commuters do not deliberate on the mode of transport on a daily basis when they become habitual. Commuters are, however, forced to deliberate on their mode use choice when a life course event or critical incident happens or is about to happen.

Klöckner (2004) proposed a theoretical framework with the view of explaining the process through which commuters go about making mode use changes when experiencing a life course event (LCE). He postulated habits are high before the occurrence of an LCE. At this point, the level of activation as defined by Klöckner (2004 p.3) as "the level to which an individual is alert and needs to reorient itself" is at a low level. Thus commuters at this stage are not aware of the need for them to change their behaviour. The search for information and deliberation is therefore low at this stage. Habits are broken when an LCE occurs and in line with this, the levels of activation, deliberation and information seeking rise. This has been the conventional thinking about how life course events influence travel choices and has reflected in the timing of mode use change intervention applications (see Bamberg 2006).

This process of mode use change as proposed by Klöckner (2004) may be true for 'critical incidents' as they happen without any prior warnings but may not be always true for life course events, which are mostly expected. The results from the study have shown that commuters, experiencing life course events – at least for the three investigated – start to deliberate on their mode use choice before the occurrence of the event. This may be so as life course events such as acquiring a car, driver's licence, co-partnership, changing residence, changing job location are usually expected occurrences in one's life, at least for a short period before they occur. Individuals may therefore plan their travel choices in expectation of the life course event. For example, an individual may even use an availability of a mode of transport as a factor in choosing where to move residence. Habits are however broken – that is the actual change in mode – when the life course event occurs.

A modification of the diagram to theoretically explain the process through which commuters change their mode use when influenced by a life course event is therefore proposed (Figure 4-17), at least for the three life course events investigated – changes in employment, changes in residence and buying of first car. From the diagram, commuters become aware of the need to change their mode of transport before the LCE occurs. In line with this, they start to search for information and deliberate on a mode use change, increasing their levels of activation, information seeking and deliberation up to the point where the LCE occurs. The level of habit – at least from the overt use of a mode of transport – remains high and does not change until the occurrence of the LCE. Old habits are broken and new ones formed. The influence of habits on mode use choice increases over time once again, reducing the level of activation.

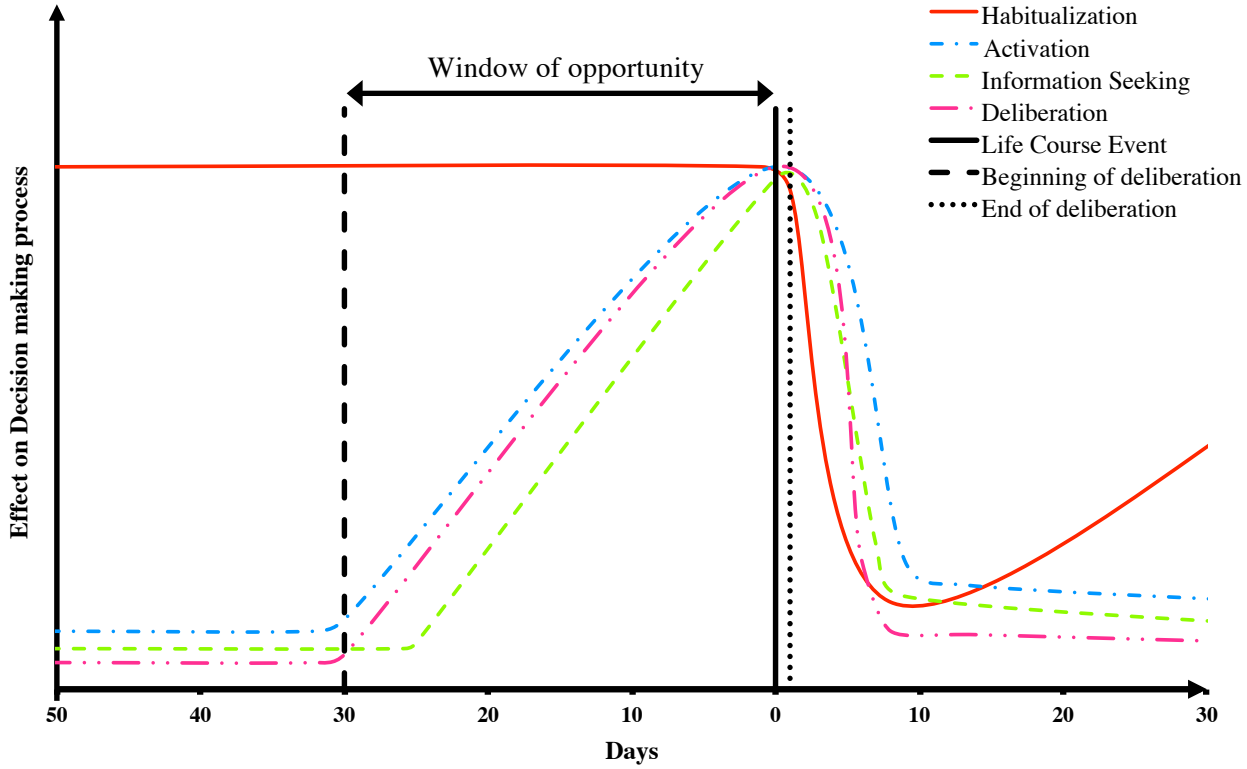


Figure 4-17: Influence of life event on habits, awareness, information seeking and deliberation: Improved version

From the theoretical process an individual goes through in making mode use changes and the results from the study, it is recommended for the administration of TDM interventions to be started before the occurrence of the life course event. At least 30 days before the occurrence of the event. This has been observed to be the 'window of opportunity' for the three life course events studied. This may be the time that commuters are actively searching for information and deliberating on mode use changes in anticipation of a life course event. Starting the application of a TDM intervention when the life course event occurs may just be too late. The major problem, however, for transport planners is how to anticipate the occurrence of a life course event in a commuter's life, i.e. at what point will a commuter seek new residence, new driving license, acquire a new car, etc. The question therefore is, how inter-connected are these life course events and can the occurrence of one life course event be a precursor to another?

4.6.2. Inter-relation Between Life Course Events

The occurrence of a life course event has often been proposed as the changing point in a commuter's habitual mode use pattern. The point when they start to re-deliberate on their mode of transport, hence

the most opportune time for the application of a travel demand management intervention. For example, Bamberg (2006), targeted individuals who had just moved homes with information about alternative modes of transport. Results from this study, however, suggest targeting commuters after they have experienced a life course event may be just too late. Observed changes even though positive may therefore be lower than if TDM interventions had started before the occurrence of the event as commuters would have already made their decision by the time the LCE occur. Resulting changes in mode use may increase if TDM measures start before the occurrence of the life course event, where commuters will be searching for information and deliberating on mode use changes. Identifying individuals who are likely to experience a life course event that is likely to cause a change in mode use may be difficult. Luckily, life course events have been seen to be inter-related, thus the occurrence of one life course event can be a precursor to the occurrence of another.

The inter-relation between life course events may thus be of use in this regard by predicting the occurrence of a major life course event likely to cause a change in mode use. Individuals experiencing a life course event that is likely to lead to the occurrence of a mode use changing life course event can be targeted with the interventions as commuters. For example, changes in employment – especially for a higher paying job – is likely to have an influence on the acquisition of a private vehicle. Individuals changing employment can therefore be targeted with information on alternative modes of transport, instead of waiting for them to acquire a private vehicle.

4.6.3. Attitude Towards Mode Use Before and After Change

Attitudes as postulated by Ajzen and Fishbein (2005) in their theory of planned behaviour, and Triandis (1977) in his theory of interpersonal behaviour, is preceded by behavioural beliefs. Behavioural beliefs are in turn shaped by a range of factors among which is information. Thus beliefs about a mode of transport can be formed and/or changed by the type of information assimilated by an individual. In such a scenario, the individual is most likely to have developed a positive perception about the mode of transport before using it. Bem's self-perception theory (1972) offered an alternative to how individuals change their attitude. She argued attitudinal changes could occur after an individual has enacted a behaviour. Thus the perception about a mode of transport can be changed after an individual has used it.

Bem's SPT can be seen as the most probable theory explaining the attitudinal changes observed from the respondents. Respondents' attitudes toward the different modes of transport were observed to have changed after they had a good experience with the mode of transport they had used for the first time. This positive change in attitudes was especially true for respondents that changed to public transport. Respondents had held bad perceptions about public transport before using them for the first time. This shows individuals' perception about public transport can be changed by the behaviour they engage in. This is inline with Kroesen, Handy and Chorus' (2017) research into the relation between attitudes and behaviour where they found the effect of behaviour on attitudes to be larger than the effect of attitudes on behaviour.

4.7. Conclusion

The survey aimed at understanding the effect of life course events on mode use choice among commuters. This was to understand and estimate when mode use choice habits are broken, along with when commuters start to search for information and deliberate on mode use changes in relation to the occurrence of the life course event. The study also aimed at understanding what type of information commuters seek when making mode use choice decisions.

A life course event calendar was used to aid respondents in remembering the details of the latest life course event that caused a change in mode use. A deliberation calendar was then used to record the details of mode use changes. That is, when respondents started thinking about changing their mode of transport, when they started searching for information and when they stopped in relation to when the life course event occurred. A word cloud analysis was carried out on the information respondents sought when making their mode use decision. This was to highlight the prominent words used by respondents.

Analysis of the deliberation calendar revealed respondents changed their mode of transport almost immediately after the occurrence of the life course event. They however, started deliberating and seeking information about 30 days before the life course event occurred – a period termed as a 'window of opportunity'. This 'window of opportunity' was similar for respondents that changed residence and those that bought their first car. It was however, smaller for respondents who changed their place of work.

Operational cost, comfort, travel time, convenience of mode use and safety were some of the information about alternatives that respondent sought after in their decision making process. Respondents thought more about the positives they would gain by changing to a particular mode of transport than what they would lose by stopping the use of their previous mode of transport. Prominent words from respondents about things they would gain included safety, comfort, convenience, shorter travel times, independence for commuters changing to private transport and savings on transport fares, travel times, convenience for those changing to public transport. Commuters' attitudes towards the mode of transport they changed to were more positive after they had used it for the first time than they were before.

Chapter 5. Synthesis and Conclusion

5.1. Introduction

Public transport use may still be sharing a significantly high percentage of modal shares in a lot of African cities. These high percentages of public transport mode use shares are however under threat as the economic statuses – which have been found to have a relationship with car ownership – of residents increase (UITP 2010; SA DoT 2012). They will continue to yield to private car use without the provision of appropriate travel demand management (TDM) measures. The city of Cape Town is no exception to this as private vehicle acquisition and use is on the rise. The all day modal split as at 2012 for person trips to and from the city centre stood at 61%:36%:3% for private, public and non-motorised transports (Transport for Cape Town 2013). This, the city deem undesirable as it is below the 50:50 private to public mode use share goal for 2010 set in the 2009 Integrated Transport Plan (ITP) and the 40:60 private to public mode use share goal for 2014 set in the 2013 ITP for Cape Town (City of Cape Town 2009c; Transport for Cape Town 2013). As part of efforts aimed at achieving this goal, the City launched a Travel SMART programme in 2012 which included among others, encouraging commuters into using more sustainable modes of transport. TDM measures were thus key in their view.

There have been lot of TDM measures designed and successfully implemented in several cities around the world, mostly in West European and North American cities (see MAX 2008; VTPI 2010). Their transferability from one city to the other may however be limited due to contextualisation of strategies. The understanding of individual's travel behaviour patterns is therefore important in ensuring the successful formulation and implementation of TDM measures. It is for this reason that the study looked at understanding the travel behaviour dynamics of commuters in Cape Town by unpacking how they go about changing their mode use. The thesis looks at addressing a number of key questions related to mode use choice which include; first, what are the relevance of behavioural and behavioural change theories in the formulation and implementation of TDM measures? Second, are travel choices among commuters in Cape Town habitual or deliberate? Third, what are some of the factors that influence travel choice? Fourth, what are some of the triggers of mode use changes and for how long do commuters deliberate on making changes? Fifth, are these mode-use changes uni-directional?

This thesis has therefore sought to theoretically explain the behaviour patterns of commuters in Cape Town with the aim of providing inputs into the formulation of TDM measures. It has identified key

life course events that trigger mode use changes and some of the information commuters deliberate on in making changes. The duration of these deliberations have also been established.

The remainder of the chapter is organised as follows. First, an overview of the main findings from the study is given. This has been organised under the key questions identified in the previous sections. A reflection on the results is then made. This is followed by a discussion on the policy implications of the findings for the design and implementation of TDM interventions in Cape Town. Contributions of the study towards literature and knowledge on mobility biography and TDM interventions are then elaborated upon. Factors that limited the research are then discussed, with the chapter ending with some recommendation for future research.

5.2. Main Findings

This section provides an overview of the main findings from the study. These have been grouped under the key questions identified.

What are the relevant behaviour and behaviour change theories to travel choices?

The review of behavioural and behavioural change theories resulted in the identification of four questions to which the formulations of TDM interventions have been suggested to address; how are travel choices made?; what factors influence travel choices?; when does travel change occur?; and how do decision-makers respond to interventions?. These questions were used in categorising the different behavioural and behavioural change theories deemed relevant to travel choices. Rational choice theory (RCT), prospect theory (PT), habit formation theory (HFT) and the theory of interpersonal behaviour (TIB) were argued to be answering the question of how choices are made. These theories were explicit in showing how an individual go about making choices, either deliberative on a daily basis as posited by rational choice and prospect theories or habitual as posited by habit formation theory. The theory of planned behaviour (TPB), theory of interpersonal behaviour (TIB) and norm activation theory (NAT) attempt to identify factors that come into play when travel choices are made – thus answering the question of what factors influence travel choices. Habit formation theory was also seen to answer the question of when travel changes occur, along with cognitive dissonance theory (CDT), and the stages of change model (SCM). These theories elaborated on the process through which an individual goes in

making behavioural changes. The self-perception theory (SPT) and goal setting theory (GST) were then argued to be answering the question of how decision-makers respond to interventions. The first two categories of theories were thought of to be behavioural theories while the last two were more of behavioural change theories, a distinction which is deemed important as they serve different purposes in the formulation of a travel demand management measure.

How have these theories been applied in the formulation and implementation of travel demand management measures?

The most dominant theory used for the analysis of travel behaviour choices among transport planners was observed to be the rational choice theory. Growing attention has, however, been given to other theories such as the prospect theory, habit formation theory, theory of planned behaviour and goal setting theory in travel behaviour choice research over the years. The theory of interpersonal behaviour, norm activation theory and cognitive dissonance theory, remain largely unexplored in the field of transportation planning. The theory of planned behaviour was the most linked theory – explicitly or implicitly – to the travel behaviour change experiments reviewed.

These theories should form the basis on which travel demand management measures or at least experiments are formulated and implemented if we strive for them to be successful. An understanding of how commuters make mode use choices may influence the duration for which TDM measures are applied. TDM measures may be once off if commuters are deemed to be rational, but maintained for a period of time if habitual. A good grasp of the theories can also inform the design of information packages intended for commuters. Information such as benefits or cost of using either public or private transport can be included to feed into personal beliefs; information such as public transport schedules and how to plan journeys can also be included to boost perceived behavioural control that has been argued by Ajzen's TPB and Triandis TIB to facilitate behaviour. The prospect theory teaches us to be careful when presenting information in order to avert resistance by sectors of the targeted population. For example, while habitual commuters may resist when told that their use of private transport is degrading the environment by producing high carbon emissions, they are more likely to accept if told they could save the environment by using public transport. The information should however be strong enough to initiate a level of dissonance in order to trigger change as argued by Festinger's CDT. Setting goals, which are clear, specific and challenging, have been seen to increase the probability of behaviour change – an argument by Locke and Latham's GST. The provision of encouraging feedback

increases the probability even higher. Behavioural changes are seen as a process and not an event as illustrated by the SCM theory. The provision of a conducive environment for behavioural change should therefore not be one-off events but rather continuous.

Are travel choices among commuters habitual or deliberate?

Rational choice theory (RCT) and habit formation theory (HFT) may be deemed as the two extreme theories that talk to how choices are made. Rational choice theories argue day-to-day deliberations whenever commuters are faced with a travel choice problem, while habit formation theory argues deliberation is only done when a commuter is faced with a travel choice problem for the first time, after which the choice will be repeated if the results are satisfactory.

The analysis of respondents' travel diaries revealed the habitual nature of mode use among the respondents in Cape Town. This was also apparent in some of the comments made by the respondents. They were observed to take about six years before changing their mode of transport – which were usually triggered by the occurrence of life course events. This was observed to be lower in younger generations, increasing in older generations. The habitual nature was also revealed when most respondents indicated never thinking about changing their mode use before the occurrence of the life course event and after they had settled on a new mode. Mode use deliberations were thus low before and after the occurrence of a life course event. The familiarity of respondents to certain modes – that is modes they had used before – played a major role in their decision making process as observed from some of their comments. It may also have been the reason why only about 15% indicated trying different modes of transport before settling on one.

A small percentage of variabilities were however observed in mode use to which some were routinized variabilities, whiles others were once-off due to disruptions in their regular modes of transport. Higher levels of variabilities were however, observed in travel mode attributes such as departure times, arrival times and route choices. Variabilities in arrival times were higher than that observed in departure times. With a fixed journey travelled by most respondents, as they had not changed their origin and destination in the two-week travel diary, the unpredictable nature of traffic was thought to be the most viable reason for the higher variabilities in arrival times. Lesser variabilities were observed in route choice, especially on the trip home.

Respondents in Cape Town may therefore be deemed to first consider changing their departure times and route choices before changing their mode of transport. This may have resulted in the habitual nature of mode use among respondents and the higher variabilities in departure times than in route choice. The theory that best explain mode use choices among respondents is therefore that of habit formation theory.

In the absence of TDM interventions, what triggers travel behaviour change?

Mode use choices have been observed to be habitual among respondents. Deliberation therefore becomes increasingly minimal the more habitual choices are. Inducing deliberation in choice making has been argued to break habits (Garvill, Marell *et al.* 2003). One way of inducing deliberation among commuters may be through the provision of information about alternative modes of transport. Information, which is contrary to ones' beliefs, can cause dissonance between ones behavioural cognition and environmental cognition. In an attempt at attaining consonance, an individual may change their behaviour – an assertion by Festinger's cognitive dissonance theory (CDT). Information giving may also create awareness about ones behaviour, prompting the need for a change. Through this, plans may be formed for change to happen. There is the need to maintain the context within which mode use changes occurred in order to avoid relapses to old mode use. The continuous reliability of public transport is therefore very important if changes to its use are to be maintained. Information may however be overlooked when mode use have become very habitual. This is so as habitual commuters do not actively seek information and overlook slight changes in situations around them (Verplanken and Roy 2016; Busch-Geertsema and Lanzendorf 2017). The occurrences of life course events or critical incidents have been seen to force individuals into rethinking about their mode use. The influences of habit and mode use choice are reduced, along with heighted levels of awareness about their mode of transport. Individuals are therefore more deliberative at this stage of their life, and are more likely to seek information than at any stage of the commuting life.

Changes in employment – which commanded about 50% of all mode use changes – was seen to be the most influential life course event. This was followed by changes in residence and car ownership. This influence was expected, as they were also the most observed life course event – taking about 26% of all observed events. Other high occurring events but with little influence on mode use changes were; a child going to school and household size growth – that is child birth. Their total influence amounted to less than 5% even though these occurrences amounted to about 39%. Changes in car ownership – that

is acquisition and loss – were the most telling events on mode use changes when compared to the number observed. About 67% of changes in car ownership resulted in changes in mode use.

The 'other reasons', which included critical incidents, were observed to always cause mode use changes, mostly from public to private transport. This was expected, as they were the 'other reasons' for which respondents had changed mode of transport. Some of these included the high cost of private car operation and maintenance, negative experiences with public transport such as verbal abuse, car crashes. Most of these occurrences are difficult to predict, as they are accidental. Some of these incidents – like verbal abuses – can be prevented through proper education and monitoring of public transport attendants.

Life course events and critical incidents may therefore force an individual into making changes to their mode of transport even in the absence of an active TDM intervention.

How frequently do these triggers cause changes in mode use?

These life course events occur infrequently in an individual's life. Some occur more frequently than others, for example, an individual may acquire a driver's license once in a lifetime but may change jobs several times. Not every life course event may however, trigger a change in mode use. It was observed to take on average about 6 years for life course events to trigger changes in mode use among the respondents. This duration was however not the same for all the different year group classification – thus respondents that were less than 30, between 31 to 40, 41 to 50 and 51 to 65 years of age. The duration between mode use changes was observed to be longer among the higher age classifications, taking about 4 years in the younger generation to about 8 years in the older generation. It can therefore be concluded that, the older one is, the longer the duration between mode-use changes as triggered by life course events. This was attributed to the general stability in one's life the older you get.

What theory/theories best explain travel patterns among commuters in Cape Town?

There are two main theories that can explain how different attributes of travel choices are made – rational choice theory and theory of habit formation. Rational choice theory depicts a commuter engages in daily deliberation over all aspects of their trip decision. Results however show that commuters in Cape Town do not engage in active deliberation on all aspects of their trips, with the

mode of transport being the most habitual attribute. Some variations were however observed in other attributes of trip making such as the departure time, route choice and activities along the route. Some of these variations were observed to be routine behaviours that commuters engage in. The theory of habit formation was therefore seen as the best theory to explain the travel patterns reported by commuters in Cape Town.

Are mode use changes uni-directional?

On an aggregate level, mode use changes have usually appeared to be in one direction – mostly from public transport to private transport – in most African cities. These changes have however been observed to be bi-directional when considering changes between any two modes of transport especially when they are in two different transport domains (e.g. from a bus, which is in a public transport domain to a car as a driver, which is in the private transport domain). A phenomenon termed by Goodwin (1999) as 'churning'. The resultant changes are mostly asymmetric in nature as the magnitudes of mode use change in both directions are mostly not equal. These changes are considered to be naturally occurring without the introduction of any TDM measures. For changes to be effected towards public transport, there is the need to ensure more changes from private transport to public transport than the vice versa.

The analysis of long-term mode use changes among respondents revealed changes to and from all the different mode of transport in Cape Town – providing evidence for 'churning'. The magnitude of change towards public transport was lower than that towards private transport. The change was thus asymmetric in nature, with the net change towards private transport.

When are mode use choice habits broken in relation to the occurrence of life course events?

Individuals experiencing these life course events have been argued to be most receptive of information about alternative modes of transport. The question therefore is at what point should they be targeted while experiencing these life course events, is it before they occur or after they occur? This can be answered by looking at when commuters start to seek information when experiencing these life course events and not when habits are overtly broken.

Habits were observed to be broken almost immediately after the occurrence of a life course event. Respondents, however, started thinking about mode use change and seeking information before the life course event occurred and ended almost immediately afterwards. This is the period for which the commuter is most actively looking for information on different mode use alternatives. It therefore offers a 'window of opportunity' for which commuters can be targeted with TDM intervention.

The determination of which side of the life course event, deliberation takes place was important so as to estimate the most opportune time for delivering information about different modes of transport. Information given after the occurrence of the three most influential life course events may be late, as most respondents indicated not seeking for information at that time but rather before the event occurred.

How long do commuters deliberate on mode use changes when triggered by life course events?

The question therefore is, how long is this 'window of opportunity'? That is, what is the duration between when commuters start to deliberate on mode use changes, seek information and when they stop deliberating and seeking information?

Respondents indicated taking between 1 working day and 121 working days (about 6 months) in deliberating on mode use changes before the occurrence of a life course event and up to 100 working days (5 months) after the event. On the average, they indicated using about 30 working days before the life course event and 1 day after it to deliberate. Respondents however used fewer days in seeking information as they indicated using between 1 working day and 121 working days to seek information before the event occurrence and up to 55 working days after. On the average, they used about 24 working days before the event and less than a day after the event to seek information. This resulted in a window of opportunity of about 31 working days, being defined by when commuters are still deliberating on their mode use change.

Are the 'windows of opportunity' the same for different life course events?

The windows of opportunity were analysed for the three life course events that were selected for the study. The results showed no significant difference in the number of days used in deliberation for respondents whose mode use changes were triggered by changes in residence and buying of their first

car. Respondents, whose mode use changes were triggered by changes in their job location, however took a bit less time in their deliberation.

The windows of opportunity was therefore observed to be similar for changes that resulted from the occurrence of a change in residence or buying first car but different for a change in job location.

What are the information commuters seek and use in decision-making?

Operational cost, travel time, comfort, convenience, safety and security, environmental impacts and health were some of the factors asked of respondents as to whether they considered them in their decision making or not. Most of the respondents indicated considering cost, time, comfort, convenience, safety and security. This was so for both respondents changing to public transport and those changing to private transport. The most considered information was travel time and convenience of mode use. Most respondents however reported avoiding the environmental impacts of the various modes. Respondents may therefore be said to be less altruistic in their decision-making. There was a near split among respondents when it came to considering health issues. Most respondents indicated not being influenced by what others think about their mode use before making their change, even though respondents who changed to public transport thought others in the society did not think highly of them. Societal influence on decision-making was therefore minimal among the respondents.

No significant differences were observed between respondents who changed to public transport and those who changed to private transport in most of the factors considered with the exception of comfort, safety and security – where respondents who changed to public transport considered them less.

5.3. Implications of Results for TDM Design and Implementation in Cape Town

Voluntary travel demand management measures have been seen to be less effective than non-voluntary ones as mode use changes are left to the discretion of the individual, unlike non-voluntary measures where changes are forced on them. They are however more receptive by individuals and stakeholders alike. A careful formulation and implementation of voluntary TDM measures is therefore necessary to ensure its success. This thesis provides a theoretical framework upon which TDM measures in Cape Town can be based on.

A theoretical understanding of behaviour and behaviour change backed by empirical studies is paramount in ensuring TDM measures are more successful at changing travel behaviour. TDM measures should therefore be grounded in theory. Answering the four main questions posed should be the first step to formulating an effective TDM measure. Planners should be able to understand how choices are made, what factors influence travel choices, when behavioural changes occur and how commuters may respond to TDM measures. These understandings will help in determining the duration for which the interventions should be maintained – whether once off, several days, weeks or months -; the factors to influence in order to cause a change in mode use; who and when interventions should be targeted; and how commuters will respond to the different types of TDM measures.

The travel diary analysis showed variabilities in travel choice attributes such as departure times and route choices for the case of Cape Town. These variabilities were deemed to be occurring on a daily basis as commuters looked for ways to avoid congestion and get to work on time. The fact that commuters are voluntarily changing their departure times, may show the willingness of commuters to accept TDM measures such as flexi-work and staggered shifts where commuters are offered the opportunity to decide when they start work provided they deliver the same number of working hours required of them. Such a measure, even though it may not necessarily cause changes in mode use can lead to reduction in congestion observed mostly at the peak hours.

Mode use choices were, however, observed to be largely habitual, particularly that of car use, augmenting the argument of habit playing a role in decision making by authors such as: Triandis (1977), Gärling, Fujii *et al.* (2001), Garvill, Marell *et al.* (2003), *etc.* The recognition of habit in mode use choices has significant implications for the formulation and implementation of effective TDM strategies based on voluntary measures. Traditionally, transport modelling has been based on the assumption of a rational commuter – who deliberates on alternatives whenever a mode use choice problem arises. Changes in mode use choices may thus be immediate with such a rational commuter in the presence of external stimuli. New information about alternative modes of transport may result in immediate changes. This may not be so with habitual commuters who seldom deliberate on their mode use choices and are not alert to minor changes in conditions under which they took a decision (Verplanken and Roy 2016; Busch-Geertsema and Lanzendorf 2017). The occurrences of life course events and/or critical incidents, have however been observed to induce deliberation on mode use choices. These have been argued to reduce the influence of habit on mode-use decision-making,

forcing commuters to be more deliberative and to seek new information (Verplanken and Roy 2016). Provision of voluntary travel behaviour change (VTBC) measures – such as information about alternative modes and public transport tickets – at this stage of a commuter's life have been seen to lead to higher chances of mode use changes (Fujii, Gärling *et al.* 2001; Bamberg, Ajzen *et al.* 2003; Bamberg 2006; Verplanken and Roy 2016). Commuters should therefore be targeted with interventions when they are experiencing a life course event, as they are most susceptible to changes at this stage of their life.

The timing of VTBC measures aimed at changing mode use is argued to be important in ensuring success, whether before or after the occurrence of the life course event. Literature on habit breaking appears to be suggesting that information seeking and deliberation occurs after the life course event, as illustrated in the diagram by Klöckner (2004) postulating how life course events interfere with mode choice habits. Observations from the study however indicate that for the three most influential life course events, information seeking and deliberation happens before they occur. Administering VTBC measures after the occurrence of a life course event may therefore be too late. It is therefore recommended for VTBC measures' implementation to start at least 30 working days before the occurrence of a life course event to increase the chances of it being more effective, even though some successes may be achieved when implemented after the life course event (see Bamberg 2006). This was the average period reported by respondents as having used in deliberating and seeking information on making mode use changes before the occurrence of a life course event. They almost immediately stopped deliberating and seeking information after the life course event. Busch-Geertsema and Lanzendorf (2017) suggested the provision of such measures aimed at public bus transport use before the occurrence of a life course event – transition from student life to working life in their case – may ensure public transport use habits are maintained while the event occurs.

Interventions are therefore to be targeted at commuters who are about to experience mode use changing life course events – such as acquiring a first car, changing residence and changing job locations – and not after they had experienced it. Identifying such commuters may however be difficult, as they are mostly not announced publicly. These life course events have however, been observed to be interconnected, thus, the occurrence of one life course event may lead to the other. For example, changes in co-partnership, which in itself was not seen to be a major cause of mode use change can lead to a change in residence – a major mode use change LCE. Commuters undergoing a

change in co-partnership can therefore be targeted with information on alternative modes of transport with the prospect of them changing residence at a later stage of their lives.

The presentation of information – e.g. in terms of gains or losses – has also been observed to influence commuters' receptiveness (Beale and Bonsall 2007; Avineri and Goodwin 2010). People have been argued to avoid losses – an assertion by Kahneman and Tversky (1979) prospect theory. This was evident among respondents in Cape Town as the majority indicated not considering what they would lose after they change their mode but rather what they would gain. Information such as cost, travel time, comfort, convenience, safety and security were considered by most respondents when deliberating on changing their mode. Environmental impacts of mode use and health issues associated with them were, however, avoided by the majority of respondents. This information may thus be included in the design of information packs aimed at changing mode use behaviour. Care must however be taken in the phrasing of statements, as some messages – such as 'anti-car use' messages aimed at changing private transport users to public transport use – have been observed to trigger repulsive reactions by very habitual car users (Beale and Bonsall 2007). The message must however, be strong enough to cause dissonance among targeted commuters. Such information may also cause changes in beliefs and attitudes, which have been postulated by theories such as the theory of planned behaviour (TPB) and the theory of interpersonal behaviour (TIB) as a major factor in behaviour. Information about how to use public transport, and public transport schedule may also increase the perceived behavioural control of commuters – a factor that has been argued to facilitate the enactment of behaviour in the theories of planned behaviour and interpersonal behaviour.

The relationship between attitudes and behaviour has been argued to bi-directional, that is, not only do attitudes influence behaviour, but behaviour also influences attitudes, an assertion by Bem's Self-Perception theory. Kroesen, Handy *et al.* (2017) moved further to argue the influence of behaviour on attitudes may even be greater than that of attitudes on behaviour. The influence of behaviour on attitudes was evident in the study when respondents' perceptions towards a mode of transport – especially public transports – were generally more positive than they were before using it for the first time. This shows that, the provision of incentives such as free public transport tickets for commuters to try out public transport can cause attitudinal changes towards their usage, even more than the provision of just information.

The 'churning' effect of mode use as evident from the mobility biography tells us that even though there is a net change from public transport to car use, there are changes from car to public transport use. This gives transport planners hope of effecting changes from car to public transport use even though the magnitude of change at the moment is very small. It also shows it may be near impossible to totally prevent changes from public transport to car use. To revert the aggregated change, there is the need for more changes from cars to public transport use than from public transport to car use. A TDM measure that is successful in shifting changes to public transport use may lead to the removal of private cars on the roadway. This may lead to a reduction in congestion, which in turn lead to reduction in delays. Travel times may therefore be reduced, leading to lowering the general cost of using private transport. This may induce new private vehicle users. The total effect of the TDM measure – mostly in terms of the shift in modal share to public transport – may not be realised. To reduce the level of induced traffic, the benefits of the TDM measure should be locked in. This may include reduction in road space capacity, parking lots, *etc.* as the effect of the measure become more positive.

In summary, TDM measures design and implementation should be grounded in theory. They should be targeted at commuters who are about to experience a mode use changing life course event, as they are most susceptible to mode use changes. The most dominating life course events were changes in employment, residence and car ownership. Targeting individuals experiencing these life course events with information is more likely to lead to behavioural changes. These individuals have however been observed to mostly deliberate on mode use changes before the occurrence of the event. TDM measures should therefore be targeted at individuals with the prospects of changing job location, residences and acquiring private vehicles for the first time.

5.4. Contributions of the Thesis

Travel demand management (TDM) measures, even though limited in African cities, have often been designed and implemented without grounds in theoretical theories and empirical studies. They are usually adopted from countries that have been successfully implemented without adapting them to local context.

This research provides a theoretical framework within which TDM measures can be designed and implemented in Cape Town through the review of behaviour theories and empirical data. Through the review of the theories, four questions were identified, to which planners are advised to use in guiding them to design and implement TDM measures. These questions included; how are mode use choices made?; what factors affect choice-making?; when does behavioural change occur?; and how do decision-makers respond to behaviour change interventions? Answering these questions will help in determining the duration of a TDM measure, the type of information given to commuters, when they are targeted and the potential response to the TDM measures. This to my knowledge is the first of such review in Cape Town. It is also a contribution to the growing literature on travel behaviour and behaviour change theories.

The study through the mobility biography approach also demonstrated the largely habitual nature of mode use choices, which are mainly interrupted by the occurrence of life course events. More variabilities were observed in attributes such as departure times and route choices than in the relatively stable mode use. Changes in mode use were observed to be bi-directional when considering two modes of transport, either in the same transport domains or two different domains – providing evidence for 'churning'. The study thus contributes to the literature on habit and churning in mode use.

The study also contributed to the better understanding of the influence of life course event on mode use change decision process. Insights were given into who should be targeted with TDM interventions – individuals experiencing life course events; the type of information given to commuters – more about what they will gain when they make mode use changes and not what they will lose; and when they should be targeted – before the occurrence of the life course event, at least 30 days before the event as respondents were found to almost immediately stop deliberation and seeking information after the occurrence of a life course event. This was contrary to the conventional assumption that deliberation starts after the occurrence of a life course event. This led to an improved deliberation diagram postulated by Klöckner (2004), a major contribution to how life course events influence travel behaviour change and when interventions should be targeted.

5.5. Limitations of Research

The research aimed at understanding the thoughts of commuters who change their mode use as a result of the occurrence of life course events. There was therefore the need for longitudinal data in order to better understand long term patterns. The use of panel survey would have delivered the most accurate results. In the absence of repeated data about the same sample, a retrospective survey was used. Retrospective surveys largely depend on the capabilities of respondents to recollect past events. Memory loss and selective memory are some of the main problems affecting the accuracy of data collected through this method. Even though all efforts were used in minimising these problems – by employing the use of recall aids such as commuting history, event history calendars – data collected cannot be said to be totally free from memory losses and/or restructuring.

The first part of the study is more of an explorative nature. Hence qualitative analysis was employed for the collection of data. Despite the rich data and analysis from the respondents, care must be taken before generalising the results. The results are specific to commuters in Cape Town, even though they are in line with international literature about mode use choice and habit breaking.

5.6. Recommendations for Future Studies

It has been argued that targeting individuals with TDM measures before the occurrence of life course events is likely to lead to more successes at changing mode-use, as commuters hardly deliberated on their travel choices after a life course event occurs. Changes in mode-use usually occur almost at the same time as the occurrence of life course event. Better prediction of life course event occurrences it therefore crucial. Further studies should be carried out to better understand the inter-relationship that exists between different life course events and other factors that leads to their occurrence. This will help in predicting the occurrence of the major life course events that causes change in mode use.

Even though, this study established that deliberation and information seeking happen before the occurrence of a life course event, it did not determine the time it takes for mode use choice to become habitual among commuters. This may be important to know, as it will help in determining the duration for which conditions under which a mode of transport was chosen should be maintained. Further studies should therefore be carried out to determine the point where mode use becomes habitual.

Travel demand management (TDM) measure transferability from one place to the other has always been an issue due to the different characteristics of people in different places. They should therefore be adapted to suit the context within which it will be implemented. TDM measures should be piloted or experimented upon before enrolling them on a large scale to determine their effectiveness of at changing behaviour in the context of Cape Town. This will help in fine-tuning the measures if necessary.

Finally better support from public transport service providers is recommended for future studies into evaluating the effectiveness of different TDM measures in Cape Town. This is perceived to be necessary as the provision of information about these public transport services is likely to be accepted if they are presented in the various public transport service providers' colours and embossed with their logos.

References

Adjei, E., R. Behrens, B. Wasswa and M. Zuidgeest (2014). A Travel Behaviour Change Framework for the City of Cape Town.

Ajzen, I. (1985). From Intentions to Actions: A Theory of Planned Behaviour. Action Control: From Cognition to Behaviour. J. Kuhl and J. Beckmann. New York, Springer-Verlag: 11-39.

Ajzen, I. (1991). "The Theory of Planned Behaviour." Organizational Behaviour and Human Decision Processes **50**(2): 179-211.

Ajzen, I. (2011). "The Theory of Planned Behaviour: Reactions and Reflections." Psychology & Health **26**(9): 1113-1127.

Ajzen, I. and M. Fishbein (2005). The Influence of Attitudes on Behaviour. The Handbook of Attitudes. D. Albarracin, B. T. Johnson and M. P. Zanna. Mahwah, New Jersey, Lawrence Erlbaum Associates Inc. Publishers. **173:** 221.

Anable, J. (2005). ""Complacent Car Addicts" or "Aspiring Environmentalists"? Identifying Travel Behaviour Segments Using Attitude Theory." Transport Policy **12**(1): 65-78.

Anderson, W. P., P. S. Kanaroglou and E. J. Miller (1996). "Urban Form, Energy and the Environment: A Review of Issues, Evidence and Policy." Urban Studies **33**(1): 7-35.

Auriat, N. (1991). "Who Forgets? An Analysis of Memory Effects in a Retrospective Survey on Migration History." European Journal of Population **7**(4): 311-342.

Avineri, E. and P. Goodwin (2010). Individual Behaviour Change: Evidence in Transport and Public Health. London, UK, The Department for Transport.

Axhausen, K. W. (1995). Travel Diaries: An Annotated Catalogue - 2nd Edition. Innsbruck, Austria, Institut fur Strassenbau und Verkehrsplanung, Leopold-Franzens-Universitat.

Badoe, D. A. and E. J. Miller (2000). "Transportation-land-use Interaction: Empirical findings in North America, and their Implications for Modeling." Transportation Research Part D: Transport and Environment **5**(4): 235-263.

Bamberg, S. (2006). "Is a Residential Relocation a Good Opportunity to Change People's Travel Behaviour? Results From a Theory-Driven Intervention Study." Environment and Behaviour **38**(6): 820-840.

Bamberg, S., I. Ajzen and P. Schmidt (2003). "Choice of Travel Mode in the Theory of Planned Behaviour: The Roles of Past Behaviour, Habit, and Reasoned Action." Basic and Applied Social Psychology **25**(3): 175-187.

Bamberg, S., D. Rölle and C. Weber (2003). "Does Habitual Car Use not Lead to More Resistance to Change of Travel Mode?" Transportation **30**: 97-108.

Bamberg, S. and P. Schmidt (1999). "Regulating Transport: Behavioural Changes in the Field." Journal of Consumer Policy **22**(4): 479-509.

Bamberg, S. and P. Schmidt (2003). "Incentives, Morality, or Habit? Predicting Students' Car Use for University Routes with the Models of Ajzen, Schwartz, and Triandis." Environment and Behaviour **35**(2): 264-285.

Banister, D. (2008). "The Sustainable Mobility Paradigm." Transport Policy **15**(2): 73-80.

Barsalou, L. W., U. Neisser and E. Winograd (1988). The Content and Organization of Autobiographical Memories. Remembering Reconsidered: Ecological and Traditional Approaches to the Study of Memory. U. Neisser and E. Winograd. New York, Cambridge University Press: 193-243.

Bartlett, F. C. (1932). Remembering: A Study in Experimental and Social Psychology. Cambridge, United Kingdom, Cambridge University Press.

Bateson, M. (2010). Rational Choice Behaviour: Definitions and Evidence. Encyclopedia of Animal Behaviour. M. D. Breed and J. Moore. Oxford, Elsevier Science: 13-19.

Beale, J. R. and P. W. Bonsall (2007). "Marketing in the Bus Industry: A Psychological Interpretation of Some Attitudinal and Behavioural Outcomes." Transportation Research Part F: Traffic Psychology and Behaviour **10**(4): 271-287.

Becker, G. S. (1976). The Economic Approach to Human Behaviour. Chicago, The University of Chicago Press.

Beckett, M., J. D. Vanzo, N. Sastry, C. Panis and C. Peterson (2001). "The Quality of Retrospective Data: An Examination of Long-Term Recall in a Developing Country." The Journal of Human Resources **36**(3): 593-625.

Behrens, R., E. Adjei, N. Covary, R. Jobanputra, B. Wasswa and M. Zuidgeest (2015). A Travel Behaviour Change Framework for the City of Cape Town. 34th Southern African Transport Conference, Pretoria, South Africa.

Behrens, R. and R. Del Mistro (2006). Methodological Problems in the Analysis of Changing Habitual Travel Behaviour Over Time. 25th South African Transport Conference Pretoria, South Africa.

Beige, S. and K. W. Axhausen (2006). Long-term Mobility Decisions during the Life Course: Experiences with a Retrospective Survey. 11th International Conference on Travel Behaviour Research. Kyoto, Japan.

Beige, S. and K. W. Axhausen (2008). "Long-Term and Mid-Term Mobility Decisions During the Life Course: Experiences with a Retrospective Survey." IATSS Research **32**(2): 16-33.

Beirão, G. and J. A. Sarsfield Cabral (2007). "Understanding Attitudes towards Public Transport and Private Car: A Qualitative Study." Transport Policy **14**(6): 478-489.

Belli, R. F. (1998). "The Structure of Autobiographical Memory and the Event History Calendar: Potential Improvements in the Quality of Retrospective Reports in Surveys." Memory **6**(4): 383-406.

Belli, R. F., W. L. Shay and F. P. Stafford (2001). "Event History Calendars and Question List Surveys: A Direct Comparison of Interviewing Methods." Public Opinion Quarterly **65**(1): 45-74.

Bem, D. J. (1967). "Self-perception: An alternative Interpretation of Cognitive Dissonance Phenomena." Psychological review **74**(3): 183.

Bem, D. J. (1972). Self-perception Theory. Advances in Experimental Social psychology. L. Berkowitz. New York, Academic Press. **6:** 1-62.

Ben-Elia, E. and D. Ettema (2011). "Changing Commuters' Behavior Using Rewards: A Study of Rush-hour Avoidance." Transportation Research Part F: Traffic Psychology and Behaviour **14**(5): 354-368.

Brewer, W. F. (1994). Autobiographical Memory and Survey Research Autobiographical Memory and the Validity of Retrospective Reports. N. Schwarz and S. Sudman. New York, Springer-Verlag 11-20.

Busch-Geertsema, A. and M. Lanzendorf (2017). "From University to Work Life – Jumping behind the Wheel? Explaining Mode Change of Students Making the Transition to Professional Life." Transportation Research Part A: Policy and Practice **106**: 181-196.

Button, K., N. Ngoe and J. Hine (1993). "Modelling Vehicle Ownership and Use in Low Income Countries." Journal of Transport Economics and Policy **27**(1): 51-67.

Chatterjee, K. (2001). Asymmetric Churn - Academic Jargon or a Serious Issue for Transport Planning, Transport Planning Society.

Chatterjee, K., H. Sherwin and J. Jain (2013). "Triggers for Changes in Cycling: The Role of Life Events and Modifications to the External Environment." Journal of Transport Geography **30**(Supplement C): 183-193.

Cherrett, T. and M. McDonald (2002). "Traffic Composition during the Morning Peak Period: Implications for Urban Traffic Management Systems." European Journal of Transport and Infrastructure Research **2**(1): 41-55.

City of Cape Town (2009b). Integrated Transport Plan for the City of Cape Town, 2006 to 2011. Cape Town.

City of Cape Town (2009c). Integrated Transport Plan 2006 - 2011: Executive Summary. Cape Town.

Clark, B., K. Chatterjee, S. Melia, G. Knie and H. Laurie (2014). Examining the Relationship between Life Transitions and Travel Behaviour Change: New Insights from the UK Household

Longitudinal Study. 46th Universities' Transport Studies Group Conference, Newcastle University. Newcastle, UK.

Conway, M. and D. Bekerian (1987). Organization in Autobiographical Memory. Memory & Cognition, Springer New York. 15: 119-132.

Conway, M. A. (1996). Autobiographical Knowledge and Autobiographical Memories. Remembering our Past: Studies in Autobiographical Memory. D. C. Rubin. New York, CAmbridge University Press: 67-93.

Cullen, I. G. (1978). The Treatment of Time in the Explanation of Spatial Behaviour. Human Activity and Time Geography, 2 (Timing Space and Spacing Time). T. Carlstein, D. Parkes and N. Thrift. New York, Wiley: 27-38.

Dahlstrand, U. and A. Biel (1997). "Pro-Environmental Habits: Propensity Levels in Behavioural Change." Journal of Applied Social Psychology 27(7): 588-601.

Dargay, J., D. Gately and M. Sommer (2007). "Vehicle Ownership and Income Growth, Worldwide: 1960-2030." The Energy Journal 28(4): 143-170.

Dargay, J. M. (2001). "The Effect of Income on Car Ownership: Evidence of Asymmetry." Transportation Research Part A: Policy and Practice 35(9): 807-821.

Darnton, A. (2008). GSR Behaviour Change Knowledge Review: Reference Report: An Overview of Behaviour Change Models and their Uses, HMT Publishing Unit, London.

de Palma, A. (1998). Individual and Collective Decision Making–Application to Travel Choice. Theoretical Foundations of Travel Choice Modeling. T. Gärling, T. Laitila and K. Westin. Oxford, Elsevier Science Limited: 33-50.

Dex, S. and A. McCulloch (1998). "The Reliability of Recall Data on Unemployment." Work Employment and Society 12(3): 12.

Dill, J. and C. Mohr (2010). Long Term Evaluation of Individualized Marketing Programs for Travel Demand Management. Portland, Oregon, Oregon Transportation Research and Education Consortium.

Dowling, R. G. and S. B. Colman (1995). "Effects of Increased Highway Capacity: Results of Household Travel Behaviour Survey." Transportation Research Record(1493): 143-149.

Ebbinghaus, H. (1885). Memory: A Contribution to Experimental Psychology. New York City, Teachers College, Columbia University.

Ecola, L., C. Rohr, J. Zmud, T. Kuhnimhof and P. Phleps (2014). The Future of Driving in Developing Countries, Institute for Mobility Research.

Egmond, C. and R. Bruel (2007). Nothing is as Practical as a Good Theory: Analysis of Theories and a Tool for Developing Interventions to Influence Energy-related Behaviour, SenterNovem.

Eriksson, L., J. Garvill and A. M. Nordlund (2006). "Acceptability of travel demand management measures: The importance of problem awareness, personal norm, freedom, and fairness." Journal of Environmental Psychology 26(1): 15-26.

Eriksson, L., J. Garvill and A. M. Nordlund (2008). "Interrupting Habitual Car Use: The Importance of Car Habit Strength and Moral Motivation for Personal Car Use Reduction." Transportation Research Part F: Traffic Psychology and Behaviour 11(1): 10-23.

Evans, D. and P. Norman (1998). "Understanding Pedestrians' Road Crossing Decisions: An Application of the Theory of Planned Behaviour." Health Education Research 13(4): 481.

Experimental Economics Centre. (2006). "Decision-Making Under Uncertainty - Advance Topics: An Introduction to Prospect Theory." Retrieved 10th November, 2010, from http://www.econport.org/econport/request?page=man_ru_advanced_prospect.

Festinger, L. (1957). A Theory of Cognitive Dissonance. Stanford, California, Stanford University Press.

Fishbein, M. and I. Ajzen (1975). Belief, Attitude, Intention and Behaviour: Ain Introduction to Theory and Research. London, Addison-Wesley Publishing Company.

Foster, P. (2006). Observational Research. Data Collection and Analysis: Second Edition. R. Sapsford and V. Jupp. London, SAGE Publications Ltd.

Frasier, P. Y., L. Slatt, V. Kowlowitz and P. T. Glowa (2001). "Using the Stages of Change Model to Counsel Victims of Intimate Partner Violence." Patient Education and Counseling **43**(2): 211-217.

Freedman, D., A. Thornton, D. Camburn, D. Alwin and L. Young-DeMarco (1988). "The Life History Calendar: A Technique for Collecting Retrospective Data." Sociological Methodology **18**: 37-68.

Friedenreich, C. M. (1994). "Improving Long-Term Recall in Epidemiologic Studies." Epidemiology **5**(1): 1-4.

Fujii, S. (2007). "Communication with Non-drivers for Promoting Long-term Pro-environmental Travel Behaviour." Transportation Research Part D: Transport and Environment **12**(2): 99-102.

Fujii, S. and T. Gärling (2003). "Development of Script-based Travel Mode Choice after Forced Change." Transportation Research Part F: Traffic Psychology and Behaviour **6**(2): 117-124.

Fujii, S., T. Gärling and R. Kitamura (2001). "Changes in Drivers' Perceptions and Use of Public Transport during a Freeway Closure." Environment and behavior **33**(6): 796-808.

Fujii, S. and R. Kitamura (2003). "What does a One-month Free Bus Ticket do to Habitual Drivers? An Experimental Analysis of Habit and Attitude Change." Transportation **30**(1): 81-95.

Fujii, S. and A. Taniguchi (2005). "Reducing Family Car-use by Providing Travel Advice or Requesting Behavioural Plans: An Experimental Analysis of Travel Feedback Programs." Transportation Research Part D: Transport and Environment **10**(5): 385-393.

Fujii, S. and A. Taniguchi (2005). Travel Feedback Programs: Communicative Mobility Management Measures for Changing Travel Behavior. The Eastern Asia Society for Transportation Studies.

GABS. (2012). "Home: Golden Arrow Bus Services." Retrieved 17th March, 2016, from www.gabs.co.za.

GABS (2016). Golden Arrow Ticket System: Updrade on the Cards. Interchange. Cape Town. **25**.

Gärling, T. and K. Axhausen (2003). "Introduction: Habitual travel choice." Transportation **30**(1): 1-11.

Gärling, T. and S. Fujii (2006). Travel Behaviour Modification: Theories, Methods, and Programs. 11th International Association for Travel Behaviour Research Conference, Kyoto, Japan, Emerald Group Publishing.

Gärling, T., S. Fujii and O. Boe (2001). "Empirical Tests of a Model of Determinants of Script-based Driving Choice." Transportation Research Part F: Traffic Psychology and Behaviour **4**(2): 89-102.

Gärling, T., R. Gillholm and A. Gärling (1998). "Reintroducing Attitude Theory in Travel Behavior Research: The Validity of an Interactive Interview Procedure to Predict Car Use." Transportation **25**(2): 129-146.

Garvill, J., A. Marell and A. Nordlund (2003). "Effects of Increased Awareness on Choice of Travel Mode." Transportation **30**(1): 63-79.

Gatersleben, B. and K. M. Appleton (2007). "Contemplating Cycling to Work: Attitudes and Perceptions in Different Stages of Change." Transportation Research Part A: Policy and Practice **41**(4): 302-312.

Gibson, J. and B. Kim (2007). Measurement Error in Long-term Retrospective Recall Surveys of Earnings. Working Paper in Economics 3/07.

Glimcher, P. W., M. C. Dorris and H. M. Bayer (2005). "Physiological Utility Theory and the Neuroeconomics of Choice." Games and Economic Behaviour **52**(2): 213-256.

Goodwin, P. B. (1989). "Family changes and public transport use 1984–1987: A dynamic Analysis using Panel Data." Transportation **16**(2): 121-154.

Goodwin, P. B. (1996). "Empirical Evidence on Induced Traffic." Transportation **23**(1): 35-54.

Goodwin, P. B. (1999). "Action or Inertia? One Year on from 'A New Deal for Transport'. Transcript of Lecture given at A Transport Planning Society meeting at the Institution of Civil Engineers, 22 July 1999." Retrieved 22nd March, 2012, from http://www.tps.org.uk/files/Main/Library/1999/goodwin99.pdf.

Gordon, I. (2008). "Density and the Built Environment." Energy Policy 36(12): 4652-4656.

Graham, C. A., J. A. Catania, R. Brand, T. Duong and J. A. Canchola (2003). "Recalling Sexual Behaviour: A Methodological Analysis of Memory Recall Bias via Interview Using the Diary as the Gold Standard." The Journal of Sex Research 40(4): 325-332.

Guest, G., A. Bunce and L. Johnson (2006). "How Many Interviews Are Enough?: An Experiment with Data Saturation and Variability." Field Methods 18(1): 59-82.

Gwilliam, K. M. (2002). Cities on the Move: A World Bank Urban Transport Strategy Review. Washington D.C., World Bank Publications.

Haaga, J. G. (1988). "Reliability of Retrospective Survey Data on Infant Feeding." Demography 25(2): 307-314.

Hanson, S. and O. J. Huff (1988). "Systematic Variability in Repetitious Travel." Transportation 15(1): 111-135.

Heath, A. (1976). Rational Choice and Social Exchange: A Critique of Exchange Theory. Cambridge, England, Cambridge University Press.

Heath, Y. and R. Gifford (2002). "Extending the Theory of Planned Behaviour: Predicting the Use of Public Transportation1." Journal of Applied Social Psychology 32(10): 2154-2189.

Heine, H., R. Mautz and W. Rosenbaum (2001). Mobilität im Alltag: Warum wir nicht vom Auto Lassen. Frankfurt, Campus.

Huff, J. O. and S. Hanson (1986). "Repetition and Variability in Urban Travel." Geographical Analysis 18(2): 97-114.

Hunecke, M., A. Blöbaum, E. Matthies and R. Höger (2001). "Responsibility and Environment: Ecological Norm Orientation and External Factors in the Domain of Travel Mode Choice Behaviour." Environment and Behaviour 33(6): 830-852.

Jackson, T. (2005). Motivating Sustainable Consumption: A Review of Evidence on Consumer Behaviour and Behavioural Change. Guildford, Surrey, Sustainable Development Network.

James, W. (1890). The Principles of Psychology. Massachusetts, Harvard University Press.

Janssen, S. M. J., A. G. Chessa and J. M. J. Murre (2006). "Memory for Time: How People Date Events." Memory & Cognition 34(1): 138-147.

Jones, P., R. Gerike and G. Servente (2009). Surveys for Behavioural Experiments: Synthesis of a Workshop. Transport Survey Methods: Keeping Up with a Changing World. P. Bonnel, M. Lee-Gosselin, J. Zmud and J.-L. Madre. Bingley, United Kingdom, Emerald Group Publishing Limited.

Jordan, K., C. Jinks and P. Croft (2006). "Health Care Utilization: Measurement using Primary Care Records and Patient Recall both Showed Bias." Journal of Clinical Epidemiology 59(8): 791-797.

Joy, M. M. (2016). Organizational Behaviour. New Dehli, India, Kalyani Publishers.

Kahneman, D. and A. Tversky (1979). "Prospect Theory: An Analysis of Decision under Risk." Econometrica 47(2): 263-291.

Kitamura, R. (1990). "Panel Analysis in Transportation Planning: An Overview." Transportation Research Part A: General 24(6): 401-415.

Kitamura, R., T. Yamamoto and S. Fujii (2003). "The Effectiveness of Panels in Detecting Changes in Discrete Travel Behavior." Transportation Research Part B: Methodological 37(2): 191-206.

Klöckner, C. A. (2004). How Single Events Change Travel Mode Choice - A Life Span Perspective. The 3rd International Conference on Traffic and Transportation Psychology. Notthingham, England.

Klöckner, C. A. and E. Matthies (2004). "How Habits Interfere with Norm-directed Behaviour: A Normative Decision-making Model for Travel Mode Choice." Journal of Environmental Psychology 24(3): 319-327.

Kroesen, M., S. Handy and C. Chorus (2017). "Do Attitudes Cause Behavior or Vice Versa? An Alternative Conceptualization of the Attitude-Behavior Relationship in Travel Behavior Modeling." Transportation Research Part A: Policy and Practice 101: 190-202.

Langer, E. (1989). "Minding Matters: The Consequences of Mindlessness-mindfulness." Advances in Experimental Social psychology **22**: 137-173.

Lanzendorf, M. (2003). Mobility Biographies. A New Perspective for Understanding Travel Behaviour. 10th International Conference on Travel Behaviour Research. Lucerne, Switzerland.

Lanzendorf, M. (2006). Key Events and Their Effect on Mobility Biographies: The Case of Childbirth. 11th International Conference on Travel Behaviour Research. Kyoto, Japan.

Latham, G. P. and E. A. Locke (1991). "Self-Regulation Through Goal Setting." Organizational Behaviour and Human Decision Processes **50**(2): 212-247.

Lewin, K. (1951). Field Theory in Social Science: Selected Theoretical Papers New York, Harper & Row.

Litman, T. (2001). "Generated Traffic and Induced Travel." Institute of Transportation Engineers Journal **71**(4): 38-47.

Litman, T. (2003). "The Online TDM Encyclopedia: Mobility Management Information Gateway." Transport Policy **10**(3): 245-249.

Locke, E. A. and G. P. Latham (2002). "Building a Practically Useful Theory of Goal Setting and Task Motivation - A 35-year Odyssey." American Psychologist **57**(9): 705-717.

Locke, E. A., K. N. Shaw, L. M. Saari and G. P. Latham (1981). "Goal Setting and Task Performance: 1969 - 1980." Psychological Bulletin **90**(1): 125-152.

Loukopoulos, P. (2007). A Classification of Travel Demand Management Measures. Threats from Car Traffic to the Quality of Urban Life: Problems, Causes, and Solutions. T. Gärling and L. Steg. Amsterdam, Elsevier Ltd.

Loukopoulos, P., C. Jakobsson, T. Gärling, S. Meland and S. Fujii (2006). "Understanding the Process of Adaptation to Car-use Reduction Goals." Transportation Research Part F: Traffic Psychology and Behaviour **9**(2): 115-127.

Loukopoulos, P., C. Jakobsson, T. Gärling, C. M. Schneider and S. Fujii (2004). "Car-user Responses to Travel Demand Management Measures: Goal Setting and Choice of Adaptation Alternatives." Transportation Research Part D: Transport and Environment **9**(4): 263-280.

Martens, K. (2004). "The Bicycle as a Feedering Mode: Experiences from Three European Countries." Transportation Research Part D: Transport and Environment **9**(4): 281-294.

Mason, M. (2010). "Sample Size and Saturation in PhD Studies Using Qualitative Interviews." Qualitative Social Research **11**(3).

Mathiowetz, N. A. (2000). The Effect of Length of Recall on the Quality of Survey Data. 4th Conference on Methodological Issues in Official Statistics, Stockholm, Sweden.

Mathiowetz, N. A. and G. J. Duncan (1988). "Out of Work, Out of Mind: Response Errors in Retrospective Reports of Unemployment." Journal of Business & Economic Statistics **6**(2): 221-229.

Matthies, E., C. A. Klöckner and C. L. Preißner (2006). "Applying a Modified Moral Decision Making Model to Change Habitual Car Use: How Can Commitment be Effective?" Applied Psychology **55**(1): 91-106.

MAX (2008). WP B, TF2 Report: Review of Theory-based Intervention Studies.

May, A. D., A. F. Jopson and B. Matthews (2003). "Research Challenges in Urban Transport Policy." Transport Policy **10**(3): 157-164.

McDougall, W. (1908). An Introduction to Social Psychology. London, Methuen & Co.

Meyer, M. D. (1997). A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility. Washington, D.C. , Institute of Transportation Engineers.

Müggenburg, H., A. Busch-Geertsema and M. Lanzendorf (2015). "Mobility Biographies: A Review of Achievements and Challenges of the Mobility Biographies Approach and a Framework for Further Research." Journal of Transport Geography **46**: 151-163.

Murray, A. T., R. Davis, R. J. Stimson and L. Ferreira (1998). "Public Transportation Access." Transportation Research Part D: Transport and Environment **3**(5): 319-328.

Mutrie, N., C. Carney, A. Blamey, F. Crawford, T. Aitchison and A. Whitelaw (2002). ""Walk in to Work Out": A Randomised Controlled Trial of a Self Help Intervention to Promote Active Commuting." Journal of Epidemiology and Community Health **56**(6): 407-412.

Neuman, W. L. (2014). Social Research Methods: Qualitative and Quantitative Approaches Boston, Pearson.

Nkurunziza, A., M. Zuidgeest and M. Van Maarseveen (2012). "Identifying Potential Cycling Market Segments in Dar-es-Salaam, Tanzania." Habitat International **36**(1): 78-84.

Noland, R. B. (2001). "Relationships between Highway Capacity and Induced Vehicle Travel." Transportation Research Part A: Policy and Practice **35**(1): 47-72.

Otto, S. (2010). The Psychology of Transport Choice, Institute for Ecological Economic Research.

Ouellette, J. A. and W. Wood (1998). "Habit and Intention in Everyday Life: The Multiple Processes by which Past Behaviour Predicts Future Behavior." Psychological Bulletin **124**(1): 54.

Owens, S. (1995). "From 'Predict and Provide' to 'Predict and Prevent'?: Pricing and Planning in Transport Policy." Transport Policy **2**(1): 43-49.

Peters, H. E. (1988). "Retrospective Versus Panel Data in Analyzing Lifecycle Events." The Journal of Human Resources **23**(4): 488-513.

Phillips, P. P. and C. A. Stawarski (2008). Data Collection: Planning for and Collecting all Types of Data. San Francisco, Pfeiffer.

Prochaska, J. O. and C. C. DiClemente (1986). Towards a Comprehensive Model of Change. Treating Addictive Behaviours: Processes of Change. W. R. Miller and N. Heather. New York, Plenum Press.

Prohaska, V., N. R. Brown and R. F. Belli (1998). "Forward Telescoping: The Question Matters." Memory **6**(4): 455-465.

Raimond, T. and D. A. Hensher (1997). A Review of Empirical Studies and Applications. Panels for Transportation Planning: Methods and Applications. T. F. Golob, R. Kitamura and L. Long. Boston, Kluwer Academic Publishers: 15-72.

Rau, H. and R. Manton (2016). "Life Events and Mobility Milestones: Advances in Mobility Biography Theory and Research." Journal of Transport Geography **52**(Supplement C): 51-60.

Ritchie, J., J. Lewis and G. Elam (2003). Designing and Selecting Samples. Qualitative Research Practice: A Guide for Social Science Students and Researchers. J. Ritchie and J. Lewis. London, SAGE Publications Ltd.

Rose, G. and H. Marfurt (2007). "Travel Behaviour Change Impacts of a Major Ride to Work Day Event." Transportation Research Part A: Policy and Practice **41**(4): 351-364.

Royal Haskoning DHV (2014). Integrated Public Transport Network Plan 2032. T. f. C. Town. Cape Town.

Rubin, D. C. and A. D. Baddeley (1989). "Telescoping is not Time Compression: A Model of the Dating of Autobiographical Events." Memory & Cognition **17**(6): 8.

SA DoT (2012). Analysis of Land Passenger Transport Modal Shift in South Africa: Draft Report. Department of Transport, South Africa.

Scheiner, J. and C. Holz-Rau (2013). "Changes in Travel Mode Use after Residential Relocation: A Contribution to Mobility Biographies." Transportation **40**(2): 431-458.

Schlich, R. and K. Axhausen (2003). "Habitual Travel Behaviour: Evidence from a Six-week Travel Diary." Transportation **30**(1): 13-36.

Schoenduwe, R., M. G. Mueller, A. Peters and M. Lanzendorf (2015). "Analysing mobility biographies with the life course calendar: a retrospective survey methodology for longitudinal data collection." Journal of Transport Geography **42**: 98-109.

Schwartz, S. H. (1977). Normative Influences on Altruism. Advances in Experimental Social Psychology. L. Berkowitz. New York, Academic Press Inc. **Volume 10:** 221-279.

Schwartz, S. H. and J. A. Howard (1981). A Normative Decision-making Model of Altruism. Altruism and Helping Behaviour: Social, Personality, and Developmental Perspectives. J. P. Rushton. Hillsdale, New Jersey, Erlbaum.

Scott, J. (2000). Rational Choice Theory. Understanding Contemporary Society: Theories of the Present. G. Browning, A. Halcli and F. Webster. London, Sage Publications: 126-138.

Simon, H. A. (1955). "A Behavioural Model of Rational Choice." The Quarterly Journal of Economics **69**(1): 99-118.

Simon, H. A. (1957). Models of Man: Social and Rational; Mathematical Essays on Rational Human Behaviour in a Social Setting. New York, Wiley.

Simon, H. A. (1991). "Bounded Rationality and Organizational Learning." Organization Science **2**(1): 125-134.

Smith, J. P. and D. Thomas (2003). "Remembrances of Things Past: Test–Retest Reliability of Retrospective Migration Histories." Journal of the Royal Statistical Society: Series A (Statistics in Society) **166**(1): 23-49.

Stanbridge, K. and G. Lyons (2006). Travel Behaviour Consideration During the Process of Residential Relocation. 11th International Conference on Travel Behaviour Research. Kyoto, Japan.

Stanbridge, K., G. Lyons and S. Farthing (2004). Travel Behaviour Change and Residential Relocation. 3rd International Conference of Traffic and Transport Psychology. Nothingham, UK.

Steg, L. (2003). Factors Influencing the Acceptability and Effectiveness of Transport Pricing. Acceptability of Transport Pricing Strategies. J. Schade and B. Schlag. Amsterdam, Elsevier: 187-202.

Stern, P. C. (2000). "Toward a Coherent Theory of Environmentally Significant Behaviour." Journal of Social Issues **56**(3): 407-424.

Stopher, P., E. Clifford, N. Swann and Y. Zhang (2009). "Evaluating Voluntary Travel Behaviour Change: Suggested Guidelines and Case Studies." Transport Policy **16**(6): 315-324.

Sudman, S., N. M. Bradburn and N. Schwarz (1996). Thinking about Answers: The Application of Cognitive Processes to Survey Methodology. San Francisco, Jossey-Bass Publishers.

Taniguchi, A. and S. Fujii (2007). "Promoting Public Transport Using Marketing Techniques in Mobility Management and Verifying their Quantitative Effects." Transportation **34**(1): 37-49.

Taylor, M. A. P. and E. S. Ampt (2003). "Travelling Smarter Down Under: Policies for Voluntary Travel Behaviour Change in Australia." Transport Policy **10**(3): 165-177.

The Sustainable Transport Unit (2012). How to Travel SMART: Promoting Sustainable Transport in the Workplace. City of Cape Town.

Thorpe, N., P. Hills and S. Jaensirisak (2000). "Public Attitudes to TDM Measures: A Comparative Study." Transport Policy **7**(4): 243-257.

Tiwari, G. (2002). "Urban Transport Priorities: Meeting the Challenge of Socio-economic Diversity in Cities, a Case Study of Delhi, India." Cities **19**(2): 95-103.

TomTom International BV. (2018). "TomTom Traffic Index: Measuring Congestion Worldwide - Cape Town." Retrieved 5th June, 2018, from https://www.tomtom.com/en_gb/trafficindex/city/cape-town.

Transport for Cape Town (2013). 2013 - 2018 Comprehensive Integrated Transport Plan. City of Cape Town.

Triandis, H. C. (1977). Interpersonal Behaviour. Monterey, California, Brooks/Cole Publishing Company.

Triandis, H. C. (1980). Values, attitudes, and interpersonal behavior. Nebraska Symposium on Motivation 1979. H. E. Howe and M. M. Page. Lincoln, University of Nebraska Press. **27**: 195-259.

Tuckett, A. G. (2004). "Qualitative Research Sampling: The Very Real Complexities." Nurse Researcher **12**(1): 47-61.

Tversky, A. and D. Kahneman (1991). "Loss Aversion in Riskless Choice: A Reference-Dependent Model." The Quarterly Journal of Economics **106**(4): 1039-1061.

Tversky, A. and D. Kahneman (1992). "Advances in Prospect Theory: Cumulative Representation of Uncertainty." Journal of Risk and Uncertainty **5**(4): 297-323.

UITP (2010). Public Transport in Sub-Saharan Africa: Major Trends and Case Studies. International Association of Public Transport (UITP).

Van der Waerden, P., H. Timmermans and A. Borgers (2003). The Influence of Key Events and Critical Incidents on Transport Mode Choice Switching Behaviour: A Descriptive Analysis. 10th International Conference on Travel Behaviour Research. Lucerne, Switzerland.

van Wee, B. (2002). "Land Use and Transport: Research and Policy Challenges." Journal of Transport Geography **10**(4): 259-271.

van Wee, B. (2010). "Prospect Theory and Travel Behaviour: A Personal Reflection Based on a Seminar." European Journal of Transport and Infrastructure Research **10**(4): 385-394.

Verplanken, B., H. Aarts and A. Van Knippenberg (1997). "Habit, information acquisition, and the process of making travel mode choices." European Journal of Social Psychology **27**(5): 539-560.

Verplanken, B. and D. Roy (2016). "Empowering Interventions to Promote Sustainable Lifestyles: Testing the Habit Discontinuity Hypothesis in a Field Experiment." Journal of Environmental Psychology **45**: 127-134.

VTPI. (2010, 22nd February, 2012). "Success Stories - Example of TDM Programs that Work." Victoria Transport Policy Institute (VTPI) Retrieved 27th February, 2012, from http://www.vtpi.org/tdm/tdm71.htm.

Wall, R., P. Devine-Wright and G. A. Mill (2007). "Comparing and Combining Theories to Explain Proenvironmental Intentions." Environment and Behaviour **39**(6): 731-753.

Wall, R., P. Devine-Wright and G. A. Mill (2008). "Interactions Between Perceived Behavioural Control and Personal-Normative Motives." Journal of Mixed Methods Research **2**(1): 63-86.

Watson, J. B. (1914). Behaviour: An Introduction to Comparative Psychology. New York, Henry Holt and company.

Wen, L. M., N. Orr, J. Bindon and C. Rissel (2005). "Promoting Active Transport in a Workplace Setting: Evaluation of a Pilot Study in Australia." Health Promotion International **20**(2): 123-133.

Western Cape Provincial Government (2007). Provincial Economic Review & Outlook.

Wilkinson, P. (2000). "City Profile: Cape Town." Cities **17**(3): 195-205.

Wilson, M. and R. Sapsford (2006). Asking Questions. Data Collection and Analysis: Second Edition. R. Sapsford and V. Jupp. London, SAGE Publications Ltd.

Winston, G. C. (1989). "Imperfectly Rational Choice: Rationality as the Result of a Costly Activity." Journal of Economic Behaviour and Organization **12**(1): 67-86.

World Bank (1996). Sustainable Transport: Priorities for Policy Reform. Washington DC, World Bank.

Yang, B. and D. Lester (2008). "Reflections on Rational Choice - The Existence of Systematic Irrationality." Journal of Socio-Economics **37**(3): 1218-1233.

Ziniel, S. (2008). Telescoping. Encyclopedia of Survey Research Methods. P. J. Lavrakas, SAGE Publications, Inc. **2012**.

Appendix A: Mobility Biography Survey Questionnaire

MOBILITY BIOGRAPHY SURVEY IN CAPE TOWN

Questionnaire identification number:

Interviewer's name:

Date of first interview:

D	D	M	M	1	2

Date of second interview:

D	D	M	M	1	2

1. INTRODUCTION AND RESPONDENT SCREENING

My name is Eric Adjei. I am a PhD student at the University of Cape Town.

For my PhD, I am conducting research into people's travel history. This research is developing an innovative way of collecting information on commuting behaviour over an extended period of time.

Your participation in this research would be greatly appreciated.

Any information that you provide would be treated confidentially and would only used in this study. In the final research report, no names will be used to identify respondents. If you have any questions about the study you may contact the research supervisor, whose contact details are provided in a reference letter.

1.1	**May I proceed?**	☐ yes, proceed with interview	☐ no, terminate interview

In this study I am targeting particular types of people. To make sure I find the people I need, I would like to ask you some questions relating to your work and yourself.

1.2	**Are you currently employed?**	☐ yes	☐ no
1.3	**Does your employment require regular travel to the same place of work?**	☐ yes	☐ no
1.4	**Have you been living in Cape Town for more than half of your working life?**	☐ yes	☐ no
1.5	**Have you ever changed your way of travelling to work (i.e. by bus, by train, by car, etc.)?**	☐ yes	☐ no
1.6	**Are you between the ages of 30 and 65?**	☐ yes	☐ no
1.7	**Can you indicate in which category your combined household monthly income (before deductions) falls?** *(show respondent card)*	☐ <R5,000 ☐ >R10,000	☐ R5,000-R10,000 ☐ refuse to answer

If any of the above questions have 'no' answer, or the respondent falls into the wrong income category, thank the respondent and terminate the interview.

2. INFORMED CONSENT

Before we proceed further, I would like to explain what your participation in this study will entail.

The study will involve this interview and a possible record keeping of your daily travels for 2 weeks.

I will ask you to keep a diary relating to how you to travel to and from work. It is easy to use and should only take a few minutes a day to complete. If this is not possible, we will try to recall your daily travel patterns in the previous 2 weeks.

2.1	**Are you prepared to participate in this study on this basis?**	☐ yes, proceed with interview	☐ no, terminate interview

3. EXPLANATION OF THE INTERVIEW PROCESS

I will now explain the interview process to you.

This research is investigating why people have changed their commuting behaviour over their working lives, focusing mainly on the modes used to travel *(explain 'mode' if necessary)*.

This is how the interviews will work: Today, I will ask you questions about changes that have happened in your life from today stretching back to the beginning of your working career. The main questions will be concerning how you have been travelling to work over the years. Two calendars – event history and commuting – will be constructed concurrently to help you in remembering and cross-checking these dates.

If you are not sure of the exact year in which a particular change took place, I would like you to tell me the time period in which you **are** sure the change would have occurred.

Before we go onto the main interview, I would like to ask you about some key events which have happened in your life and when they occurred. I will ask these questions in different categories, including: where you have lived; how your household has changed; where you have worked; and some other questions such as your history of vehicle ownership.

Now let us start constructing the event history calendar after which we will go on with the main interview and construct the commuting history calendar.

4. Construction of Event History Calendar

Let's start by asking you questions about yourself, your employment history, where you have lived, household relationships, and access to cars.

4.1 **What area of the city do you currently live in?** _____

4.2 Employment history

Now I will ask you questions about your employment history.

Current job

4.2.1 **In which year did you start your current** (*main*) **job?** _____

4.2.2 **How sure are you that you started in that year?** ☐ sure, *continue* ☐ unsure, *establish year range*

Earlier job(s) (repeated as necessary)

4.2.3 **Did you move straight from an earlier job to this job?** ☐ yes, *continue* ☐ no, *establish time gap*

4.2.4 **In which year did you start the earlier job?** _____

4.2.5 **How sure are you that you started in that year?** ☐ sure, *continue* ☐ unsure, *establish year range*

4.3 Residential history

I will now ask you questions about all the homes you have lived in during your working life.

Current home

4.3.1 **In which year did you move into your current home?** _____

4.3.2 **How sure are you that you moved in that year?** ☐ sure, *continue* ☐ unsure, *establish year range*

Earlier home(s) (repeated as necessary)

4.3.3	**Did you move straight from an earlier home into this home?**	☐ yes, *continue*	☐ no, *establish time gap*
4.3.4	**In which year did you move into this home?**	_____	
4.3.5	**How sure are you that you moved in that year?**	☐ sure, *continue*	☐ unsure, *establish year range*

4.4 Co-habiting partnerships

Now, I will ask you questions about the times that you have lived together with a partner, whether or not you were married, during your working life. I will also ask you to indicate the times when you were not living with a partner.

Current partner

4.4.1	**Do you currently live with a partner?**	☐ yes, *continue*	☐ no, *go to Q4.4.4*
4.4.2	**In which year did you start living with your current partner?**	_____	
4.4.3	**How sure are you that you started living together in that year?**	☐ sure, *continue*	☐ unsure, *establish year range*

Earlier partner(s) (repeated as necessary)

4.4.4	**Did you have any co-habiting partnerships before this?**	☐ yes, *continue*	☐ no, *go to Q4.5*
4.4.5	**When did you start this co-habiting partnership?**	_____	
4.4.6	**How sure are you that you began to co-habit in that year?**	☐ sure, *continue*	☐ unsure, *establish year range*
4.4.7	**When did this co-habiting partnership end?**	_____	
4.4.8	**How sure are you that you ceased to co-habit in that year?**	☐ sure, *continue*	☐ unsure, *establish year range*

4.5 Children

If applicable, I will now ask you questions about the birth of children, as well as when they went to school and left home.

4.5.1	**Do you have children who live, or lived, with you?**	☐ yes, *continue*	☐ no, *go to Q4.6*
4.5.2	**How many children?**	_____	

Child (Q4.5.3 – Q4.5.10 repeated as necessary)

4.5.3	**In which year was your (first, second, etc.) child born/start living with you?**	_____	
4.5.4	**If applicable, when did this child stop living with you?**	_____	☐ still lives with me
4.5.5	**Has this child started/completed school?**	☐ yes, *continue*	☐ child has not started school, *go to Q4.5.3 or Q4.6*
4.5.6	**In which year did this child start at his/her first school** (*while living with you*)**?**	_____	
4.5.7	**In which year did this child leave his/her first school?**	_____	☐ still at first school, *go to Q4.5.3 or Q4.6*
4.5.8	**How sure are you of these dates?**	☐ sure, *continue*	☐ unsure, *establish year range*

Next school (Q4.5.9 – Q4.5.10 repeated as necessary)

4.5.9	**In which year did this child leave his/her next school?**	_____	
4.5.10	**How sure are you of this date?**	☐ sure, *continue*	☐ unsure, *establish year range*

4.6 Private mobility tools

I will now ask you questions about access to use of cars, during your working life.

Drivers license

4.6.1	**Do you have a drivers license?**	☐ yes, *continue*	☐ no, *go to section 5*
4.6.2	**In which year did you get your drivers license?**	_____	
4.6.3	**How sure are you of this date?**	☐ sure, *continue*	☐ unsure, *establish year range*

Car access

4.6.4	**Have you ever owned, or had access to the** (*autonomous*) **use of, a car during your working life?**	☐ yes, *continue*	☐ no, *go to section 5*

First period of car access

4.6.5	**Did you own, or have access to the** (*autonomous*) **use of, a car when you started your working life?**	☐ yes, *go to Q4.6.8*	☐ no, *continue*
4.6.6	**In which year did first own, or have access to the** (*autonomous*) **use of, a car?**	_____	
4.6.7	**How sure are you of this date?**	☐ sure, *continue*	☐ unsure, *establish year range*
4.6.8	**Have you always owned (had access to) a car since this date/then?**	☐ yes, *go to section 7*	☐ no, *continue*
4.6.9	**In which year did you cease to own, or have access to the** (*autonomous*) **use of, a car?**	_____	
4.6.10	**How sure are you of this date?**	☐ sure, *continue*	☐ unsure, *establish year range*

(If applicable) Second period of car access (repeated as necessary)

4.6.11	**In which year did next own, or have access to the** (*autonomous*) **use of, a car?**	_____	
4.6.12	**How sure are you of this date?**	☐ sure, *continue*	☐ unsure, *establish year range*
4.6.13	**Have you always owned (had access to) a car since this date/then?**	☐ yes, go to section 6	☐ no, continue
4.6.14	**In which year did you cease to own, or have access to the** (*autonomous*) **use of, a car?**	_____	
4.6.15	**How sure are you of this date?**	☐ sure, *continue*	☐ unsure, *establish year range*

5. Construction of Commuting History Calendar

Let's continue by asking you questions about how you currently travel to work and how you travelled to work in the past.

5.1 Current mode of travel

5.1.1 **What area of the city do you currently live in?** _____

5.1.2 **What area of the city do you currently work in?** _____

5.1.3 **What is your current mode of travel to work?** *(most frequently used)*

☐ walk
☐ bicycle
☐ car driver
☐ car passenger
☐ minibus-taxi
☐ bus
☐ train
☐ other, _____

5.1.4 **In which year did you start commuting to work by …** (*current mode of travel*)**?** _____

5.1.5 **How sure are you that you started commuting in this way in that year?**

☐ sure, *continue*
☐ unsure*, establish year range*

5.1.6 **Before settling on your current mode did you ever try travelling in a different way? If so, what did you try, why did you try it, and why didn't you stick with it?**

☐ did not try another travel mode

_____

_____

_____

_____

_____

_____

_____

_____

_____

5.1 Earlier mode of travel (repeat as necessary)

5.2.1 **How did you commute to work before this date (settling on current mode use)?**

☐ walk all the way
☐ car driver
☐ car passenger
☐ minibus-taxi
☐ bus
☐ train
☐ other, _____

5.2.2 **Why did you change from … to … at this time?**
(*Write detailed notes on the reasons given in the space below, which can be typed up later*

5.2.3 **Before settling on the change, did you try other ways of travelling? If so, what did you try?**

5.2.4 **Before the change, how often did you typically use … to get to work in a working week?**

☐ every weekday
☐ 4 times a week
☐ cannot remember
☐ 3 times a week
☐ 2 times a week

5.2.5 (*If the respondent indicated that he/ she used the most frequent mode 2-4 times a week*) **How did you travel to work on the other weekdays, and why?** (*Write notes on the explanation given in the space below, which can be typed up later)*

☐ used same mode every weekday

5.1 Earlier mode of travel (repeat as necessary)

5.2.1 **How did you commute to work before this date (settling on current mode use)?**

☐ walk all the way
☐ car driver
☐ car passenger
☐ minibus-taxi
☐ bus
☐ train
☐ other, _____

5.2.2 **Why did you change from … to … at this time?**
(*Write detailed notes on the reasons given in the space below, which can be typed up later*

5.2.3 **Before settling on the change, did you try other ways of travelling? If so, what did you try?**

5.2.4 **Before the change, how often did you typically use … to get to work in a working week?**

☐ every weekday
☐ 4 times a week
☐ cannot remember
☐ 3 times a week
☐ 2 times a week

5.2.5 (*If the respondent indicated that he/ she used the most frequent mode 2-4 times a week*) **How did you travel to work on the other weekdays, and why?** (*Write notes on the explanation given in the space below, which can be typed up later)*

☐ used same mode every weekday

5.1 Earlier mode of travel (repeat as necessary)

5.2.1 **How did you commute to work before this date (settling on current mode use)?**

☐ walk all the way
☐ car driver
☐ car passenger
☐ minibus-taxi
☐ bus
☐ train
☐ other, _____

5.2.2 **Why did you change from … to … at this time?**
(*Write detailed notes on the reasons given in the space below, which can be typed up later*

5.2.3 **Before settling on the change, did you try other ways of travelling? If so, what did you try?**

5.2.4 **Before the change, how often did you typically use … to get to work in a working week?**

☐ every weekday
☐ 4 times a week
☐ cannot remember
☐ 3 times a week
☐ 2 times a week

5.2.5 (*If the respondent indicated that he/ she used the most frequent mode 2-4 times a week*) **How did you travel to work on the other weekdays, and why?** (*Write notes on the explanation given in the space below, which can be typed up later)*

☐ used same mode every weekday

5.1 Earlier mode of travel (repeat as necessary)

5.2.1 **How did you commute to work before this date (settling on current mode use)?**

☐ walk all the way
☐ car driver
☐ car passenger
☐ minibus-taxi
☐ bus
☐ train
☐ other, _____

5.2.2 **Why did you change from … to … at this time?**
(*Write detailed notes on the reasons given in the space below, which can be typed up later*

5.2.3 **Before settling on the change, did you try other ways of travelling? If so, what did you try?**

5.2.4 **Before the change, how often did you typically use … to get to work in a working week?**

☐ every weekday
☐ 4 times a week
☐ cannot remember
☐ 3 times a week
☐ 2 times a week

5.2.5 (*If the respondent indicated that he/ she used the most frequent mode 2-4 times a week*) **How did you travel to work on the other weekdays, and why?** (*Write notes on the explanation given in the space below, which can be typed up later)*

☐ used same mode every weekday

6. Respondent's Information *(to be filled in by interviewer after the first interview)*

6.1	**How old are you?**	_____ years	
6.2	**Respondent gender**	☐ male	☐ female
6.3	**Respondent race**	☐ Black	☐ Coloured
		☐ White	☐ Indian
		☐ other, _____	

7. TRAVEL DIARY

We have now finished with the main interview.

Now I will explain to you how a commuting diary needs to be filled in(*show example*).

As you can see, the diary is divided into 5 columns, one for each weekday, and 2 rows, one for the trip to and the other for the trip from work.

Let's start by filling in the information in your diary for yesterday/previous weekday.

6.1	**What day would this be?**	☐ Monday	☐ Thursday
		☐ Tuesday	☐ Friday
		☐ Wednesday	
6.2	**What date would this be?**	_____ 2012	

Fill in the dairy for this day with the respondent, explaining the different questions as you go.

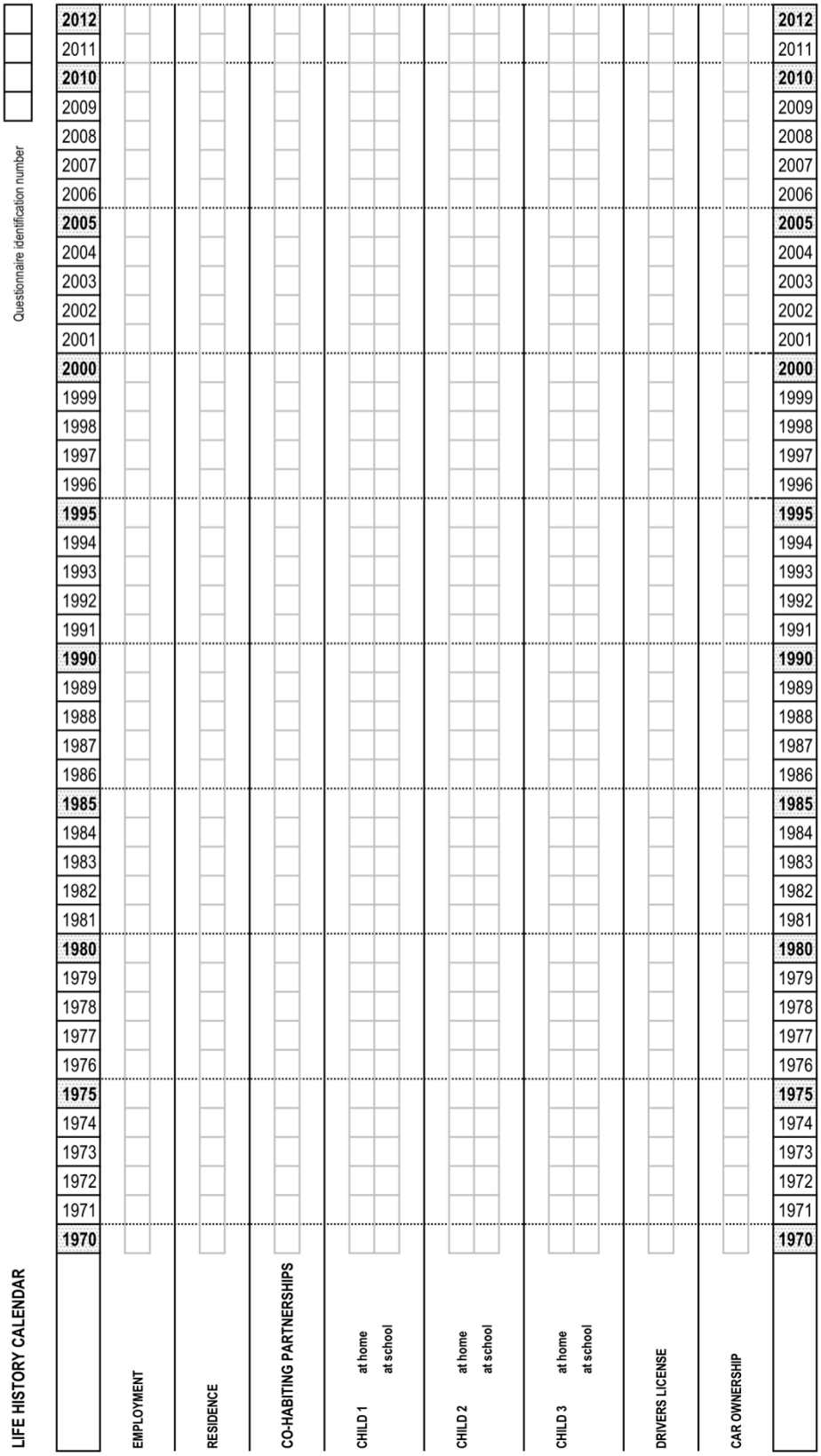
Before ending the interview, make sure to arrange a date to collect the travel diary.

Date and time arranged to collect diary. _____ 2012

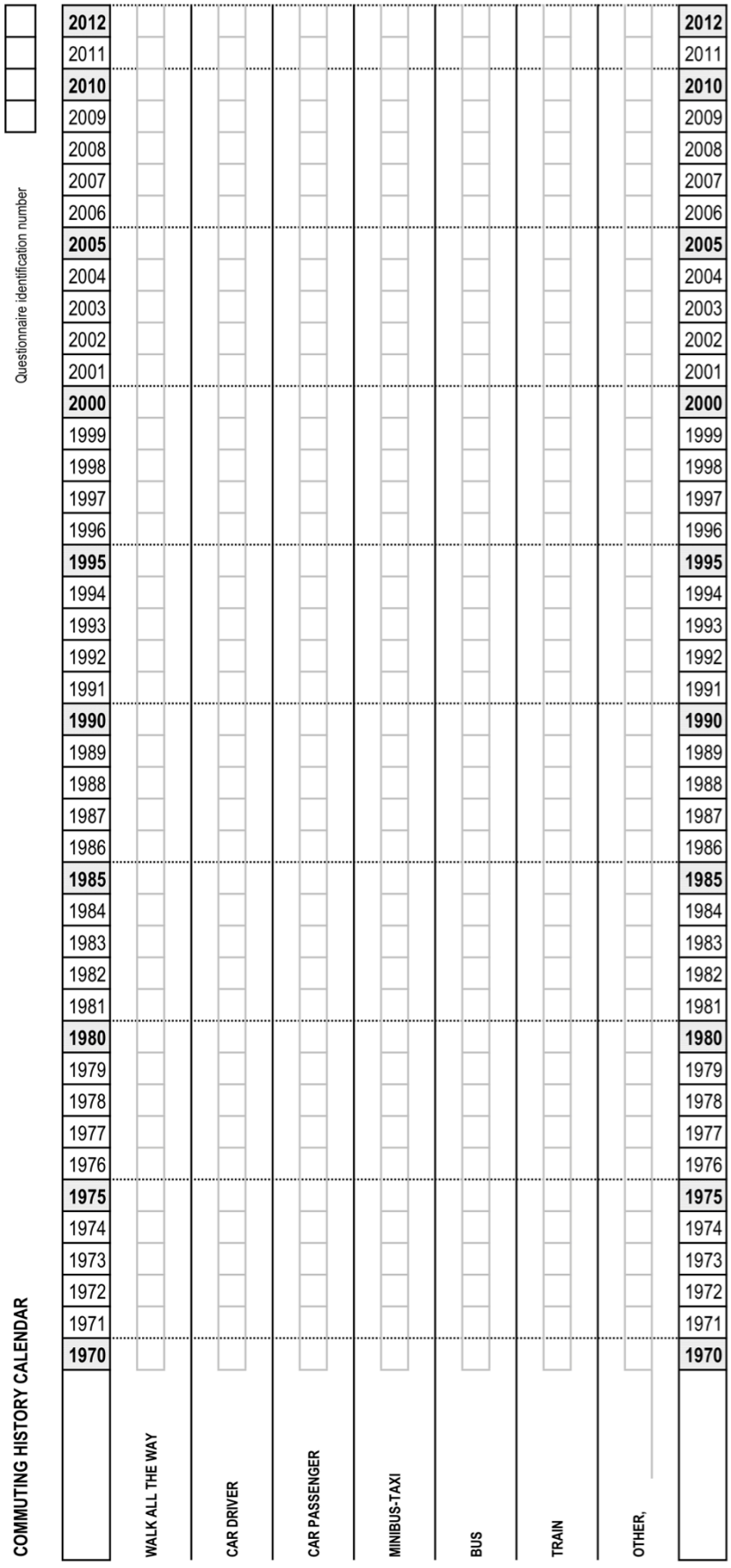
Venue arranged for the collection. _____

Thank you very much for your time.

Appendix B: Life History Calendar



Appendix C: Commuting History Calendar



COMMUTING DIARY (WEEK #_____)

Questionnaire identification number

TRAVEL TO WORK

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Was this the same trip origin as yesterday?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
Was this the same trip destination as yesterday?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
What was the time of departure from origin?	h	h	h	h	h
What was the arrival time at work?	h	h	h	h	h
Did you follow the same route today as yesterday?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
Did you stop to do anything on the way?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
What travel mode was used?	walk	walk	walk	walk	walk
Number the travel modes used (even if just one) to show the order they were used.	car driver	car driver	car driver	car driver	car driver
	car passenger	car passenger	car passenger	car passenger	car passenger
	minibus-taxi	minibus-taxi	minibus-taxi	minibus-taxi	minibus-taxi
	bus	bus	bus	bus	bus
Circle the mode used that covered the greatest distance.	train	train	train	train	train
	other,	other,	other,	other,	other,
If a car was used, how many people were in it (including yourself)?					

TRAVEL FROM WORK

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Was this the same trip origin as yesterday?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
Was this the same trip destination as yesterday?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
What was the time of departure from work?	h	h	h	h	h
What was the arrival time at destination?	h	h	h	h	h
Did you follow the same route today as yesterday?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
Did you stop to do anything on the way?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
What travel mode was used?	walk	walk	walk	walk	walk
Number the travel modes used (even if just one) to show the order they were used.	car driver	car driver	car driver	car driver	car driver
	car passenger	car passenger	car passenger	car passenger	car passenger
	minibus-taxi	minibus-taxi	minibus-taxi	minibus-taxi	minibus-taxi
	bus	bus	bus	bus	bus
Circle the mode used that covered the greatest distance.	train	train	train	train	train
	other,	other,	other,	other,	other,
If a car was used, how many people were in it (including yourself)?					

Appendix E: Mobility Biography Survey Questionnaire – Deliberation

MOBILITY BIOGRAPHY SURVEY IN CAPE TOWN

Questionnaire identification number:

Interviewer's name:

Date of interview:

D	D	M	M	1	6

I. INTRODUCTION AND RESPONDENT SCREENING

My name is ……., a student at UCT.

We are conducting research into people's travel history. This research seeks to explore the influences of certain lifetime events on mode use.

Your participation in this research would be greatly appreciated.

Any information that you provide would be treated confidentially and would only be used in this study. In the final research report, no names will be used to identify respondents. If you have any questions about the study, you may contact the research supervisor on 021 650 4757.

1.	**May I proceed?**	☐ yes, proceed with interview	☐ no, terminate interview

In this study we am targeting particular types of people. To make sure we find the people we need, I would like to ask you some questions relating to your work and yourself.

2.	**Are you currently employed?**	☐ yes	☐ no
3.	**Does your employment require travelling at least 3 times a week to the same place of work?**	☐ yes	☐ no
4.	**Have you experienced in the past 5 years any of the following that made you change how you travel to work: change in job location, change in residence or acquired your first car?**	☐ yes	☐ no

If any of the above questions have 'no' answer, thank the respondent and terminate the interview.

II. EXPLANATION OF INTERVIEW AND INFORMED CONSENT

Before we proceed further, I would like to explain what your participation in this study would entail.

The study will involve this interview, which should take about 30 minutes.

This research is investigating why people have changed their commuting behaviour over their working lives, focusing mainly on the mode of transport used *(explain 'mode' if necessary)* and when the decision to change mode began.

I will ask you questions about your current travel patterns. I will also ask you questions about events that have occurred in your life and whether they have had an impact on your mode use. I will then ask you when you started deliberating on changing mode, how long it took and some of the factors you considered when changing mode.

Any information provided will be treated confidentially and would only be used in this study. No identity tags will be used in the final report.

Your participation in this research is entirely voluntary and you may choose to withdraw from the study whenever you wish.

5.	**Are you prepared to participate in this study on this basis?**	□ yes, proceed with interview	□ no, terminate interview

Now let us start with the survey.

Show illustrated example of event history and mode use calendars, explaining to respondent that we hope to replicate this during the interview.

6. Current mode of transport

I will start by asking you questions about yourself and the mode of transport you are currently using

6.1 **In what year were you born?**

Y	Y	Y	Y

6.2 **In which suburb of the city are you currently residing?**

_____

6.3 **In which suburb is your current place of work?**

_____

6.4 **What mode of transport do you currently use most often to travel to your work place?**

- ☐ Metro rail
- ☐ MyCiTi bus
- ☐ Golden Arrow bus
- ☐ Mini-bus taxi
- ☐ Car as a passenger
- ☐ Car as a driver
- ☐ Walk
- ☐ _____

6.5 **Thinking about the last 3 months, how many times a week do you normally travel to work with this mode of transport?**

☐ Three days in a week ☐ Four days in a week ☐ Every working day of the week

6.6 **If you are currently using a car, what other mode of transport have you ever used to travel to work?**

☐ MetroRail ☐ MyCiTi bus ☐ Golden arrow bus ☐ Mini-bus taxi ☐ Walking

6.7 **Have you ever bought or been given the use of a car?**

☐ Yes ☐ No, *go to section 7*

6.8 **What was the main reason behind the acquisition of the car?**

_____

_____

_____

_____

_____

7. Construction of Event History Calendar

I will now ask you questions about your employment history, where you have lived, household relationships, and access to cars.

7.2 Employment history

Let's start with questions about your employment history.

Start completing the event history calendar as questions are been asked.
Each box represents a year in the different events. Changes in those events are shaded and connected by a straight line.

Current job

7.2.1 **In which year did you start working at your current job location?**

Earlier job(s) (repeat as necessary)

7.2.2 **Did you move straight from an earlier job location to this job location?**

☐ Yes ☐ No, *establish time gap*

7.2.3 **In which year did you start working at the earlier job location?**

7.2.4 **Was this your first job location?**

☐ Yes ☐ No, *go to Q7.2.2*

7.3 Residential history

I will now ask you questions about all the homes you have lived in during your working life.

Current home

7.3.1 **In which year did you move into your current home?**

Earlier home(s) (repeat as necessary)

7.3.2 **Did you move straight from an earlier home into this home?**

☐ Yes ☐ No, *establish time gap*

7.3.3 **In which year did you move into this earlier home?**

7.3.4 **Was this your first home since you started working?**

☐ Yes ☐ No, *go to Q7.3.2*

7.4 Co-habiting partnerships

Now, I will ask you questions about the times that you have lived together with a partner, irrespective of whether or not you were married, during your working life. I will also ask you to indicate the times when you were not living with a partner. I am asking these questions because the people we live with can have an important influence on how we travel.

Current partner

7.4.1 **Do you currently live with a partner?**

☐ Yes ☐ No, *go to Q 7.4.3*

7.4.2 **In which year did start living with your current partner?**

Earlier partner(s) (repeat as necessary)

7.4.3 **Have you had any co-habiting partnerships before this?**

☐ Yes ☐ No, *go to section 7.5*

7.4.4 **When did you start this co-habiting partnership?**

7.4.5 **When did this co-habiting partnership end?**

7.4.6 **Was this your first co-habiting partnership?**

☐ Yes ☐ No, *go to Q7.4.3*

7.5 Children

If applicable, I will now ask you questions about the birth of children, as well as when they went to school and left home. I am asking these questions because having children, and sending them to school, can have an important influence on how we travel.

7.5.1 **Do you have children who live, or lived, with you?**

☐ Yes ☐ No, *go to section 7.6*

7.5.2 **How many children?**

_____

Child (repeat as necessary)

7.5.3 **In which year was your (first, second, etc.) child born/started living with you?**

7.5.4 **If applicable, when did this child stop living with you?**

7.5.5 **Has this child started/completed school?**

☐ Yes ☐ No, *go to section 7.6*

7.5.6 **In which year did this child start his/her first school?**

7.5.7 **In which year did this child leave his/her first school?**

Next school (repeat as necessary)

7.5.8 **In which year did this child start his/her next school?**

7.5.9 **In which year did this child leave his/her next school?**

7.5.10 **Is this your first child?**

☐ Yes ☐ No, *go to Q7.5.3*

7.6 Private mobility tools

I will now ask you questions about access to the use of cars, during your working life.

Drivers license

7.6.1 **Do you have a driver's license?**

☐ Yes ☐ No, *go to Q 7.6.3*

7.6.2 **In which year did you get your driver's license?**

Car access

7.6.3 **Have you ever owned, or had access to the use of a car to travel to work during your working life?**

☐ Yes ☐ No, *go to section 8*

First period of car access

7.6.4 **Did you own, or have access to the use of a car when you started your working life?**

☐ Yes ☐ No

7.6.5 **In which year did you first own, or have access to the use of a car?**

7.6.6 **Have you always owned or had access to this car since that date?**

☐ Yes, *go to section 8* ☐ No

7.6.7 **In which year did you cease to own or have access to the use of this car?**

(If applicable) Second period of car access (repeat as necessary)

7.6.8 **In which year did you own or have access to the use of your next car?**

7.6.9 **Have you always owned or had access to this car since that date?**

☐ Yes, *go to section 8* ☐ No

7.6.10 **In which year did you cease to own or have access to the use of this car?**

7.6.11 **Was this your first access to a car?**

☐ Yes ☐ No, *go to Q7.6.8*

8. Latest Event Occurrence

I will now ask you questions about the most recent time that you changed your mode of transport as a result of changing residence, changing job location or acquiring your first car.

8.1 **Which of the following events you have experienced in your working life is the most recent that caused you to change your mode of transport to work? Either**

☐ buying your first car ☐ changing where you live ☐ changing where you work

8.2 **Did any of the other events listed in the event history calendar influence buying your first car/changing where you live/changing where you work?**

☐ Yes ☐ No, *go to Q8.4*

8.3 **Please indicate which of the following events influenced buying your first car/changing where you live/changing where you work?**

☐ Changed job location
☐ Changed residence
☐ Changed co-habiting partnerships
☐ Had a new child in the home
☐ Bought my first car
☐ I acquired my driver's license
☐ Other _____

Write down any comments below

_____

_____

_____

_____

8.4 **What mode of transport to work were you using before buying your first car/changing where you live/changing where you work?**

- ☐ MetroRail
- ☐ MyCiTi bus
- ☐ Golden arrow bus
- ☐ Mini-bus taxi
- ☐ Car as a passenger
- ☐ Car as a driver
- ☐ Walk
- ☐ Other _____

8.5 **Did you ever consider changing your mode of transport before buying your first car/changing where you live/changing where you work?**

- ☐ Yes
- ☐ No, *go to section 9*

8.6 **What prevented you from changing your mode of transport before buying your first car/changing where you live/changing where you work?**

9 Construction of Mode Use Calendar

I will now ask you questions about when you started thinking about changing your mode of transport, whether or not you changed your departure times, route and tried different modes of transport.

All timeline answers are to be filled on the mode use calendar

9.1 **When did you start thinking about how you will travel to work in relation to buying your first car/changing where you live/changing where you work?**

To be filled in the deliberation part of the mode use calendar

9.2 **When did you stop thinking about how you will travel to work in relation to buying your first car/changing where you live/changing where you work?**

To be filled in the deliberation part of the mode use calendar

9.3 **When did you actually started looking for information such as cost, travel times, etc.?**

To be filled in the information seeking part of the mode use calendar

9.4 **When did you stop looking for information such as cost, travel times, etc.?**

To be filled in the information seeking part of the mode use calendar

9.5 **How many days/weeks after buying your first car/changing where you live/changing where you work did you change your mode of transport to work?**

9.6 **Before changing your mode of transport, did you try changing your departure time from home?**

☐ Yes ☐ No, *go to Q9.11*

9.7 **How many days/weeks after buying your first car/changing where you live/changing where you work did you start changing your departure time?**

9.8 **For how long did you change your departure time?**

Write down any comments below

9.9 **Were you satisfied with your travel patterns after you changed your departure time?**

☐ Yes ☐ No, *go to Q9.11*

9.10 **If yes, then why didn't you stick with your previous mode of transport to work?**

9.11 **Before changing your mode of transport, did you try changing your route to work?**

☐ Yes ☐ No, *go to Q9.16*

9.12 **How many days/weeks after buying your first car/changing where you live/changing where you work did you start changing your route to work?**

9.13 **For how long did you change your route to work?**

Write down any comments below

9.14 **Were you satisfied with your travel patterns after you changed your route to work?**

☐ Yes ☐ No, *go to Q9.16*

9.15 **If yes, then why didn't you stick with your previous mode of transport to work?**

9.16 **Did you try different modes of transport after buying your first car/changing where you live/changing where you work before settling on your current mode of transport?**

☐ Yes ☐ No, *go to Q9.21*

9.17 **How many days/weeks after buying your first car/changing where you live/changing where you work did you start trying different modes of transport?**

9.18 **What mode of transport to work did you try first/second…?**

☐ MetroRail
☐ MyCiTi bus
☐ Golden arrow bus
☐ Mini-bus taxi
☐ Car as a passenger
☐ Car as a driver
☐ Walk
☐ Other, _____

9.19 **For how long did you try this mode of transport to work?**

Write down any comments below

9.20 **Was this the last mode of transport you tried before settling on your current mode of transport?**

☐ Yes ☐ No, *go to Q9.18*

9.21 **Have you ever thought of changing your current mode of transport since you settled on it?**

☐ Yes ☐ No

9.22 **Why haven't you changed if you have ever thought of it?**

10. Mode Change Decision Making

I will now ask you questions about how you chose your mode of transport.

10.1 **Were you able to gather all available information you thought there was about the different modes of transport you were considering?**

☐ Yes ☐ No

10.2 **Were you satisfied with the amount of information you were able to gather in making the decision?**

☐ Yes ☐ No

10.3 **In making your decision, did you think about what you would gain by using the mode after buying your first car/changing where you live/changing where you work?**

☐ Yes ☐ No, *go to 10.6*

10.4 **What were some of the things you thought you would gain?**

10.5 **Did you actually gain the things you thought you would after the mode use change?**

☐ Yes ☐ No

10.6 **In making your decision, did you think about what you would lose by using the mode after buying your first car/changing where you live/changing where you work?**

☐ Yes ☐ No, *go to Q10.9*

10.7 **What were some of the things you thought you would lose?**

10.8 **Did you actually lose the things you thought you would after the mode use change?**

☐ Yes ☐ No

10.9 **Was this the first time you had used the mode of transport you changed to after buying your first car/changing where you live/changing where you work?**

☐ Yes ☐ No

10.10 **What were your thoughts about the mode of transport before you ever used it?**

10.11 **What were your thoughts about the mode of transport after you have used it?**

10.12 **Was your experience about the mode of transport better or worse than you expected?**

☐ Better ☐ Worse

10.13 **Please indicate if you consider the following when deciding on your mode of transport**

Operational cost	☐ Yes	☐ No
Travel time	☐ Yes	☐ No
Comfortability	☐ Yes	☐ No
Convenience	☐ Yes	☐ No
Safety and Security	☐ Yes	☐ No
Environmental Impact	☐ Yes	☐ No
Health	☐ Yes	☐ No

10.14 **Please indicate whether you agree or disagree to the following statements about your mode of transport after buying your first car/changing where you live/changing where you work.**

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree	I don't know
It is/was easier finding information than I had thought it would be	☐	☐	☐	☐	☐	☐
Traveling time to work is shorter than I thought it would be	☐	☐	☐	☐	☐	☐
Cost of travelling to work is cheaper than I thought it would be	☐	☐	☐	☐	☐	☐
I think highly of people who use this mode of transport	☐	☐	☐	☐	☐	☐
Other people in the society also think highly of people who use this mode of transport	☐	☐	☐	☐	☐	☐
What others think about the mode influenced my choice	☐	☐	☐	☐	☐	☐

Thank you for your time. I will now go off and refine the data given today. Would you like the chance to be able to review your calendars after I have

10.15 **Would you like the chance to be able to review your calendars after I have plotted them?**

☐ Yes ☐ No

10.16 **If yes, would you kindly provide us with your email address so we can contact you after?**

_____

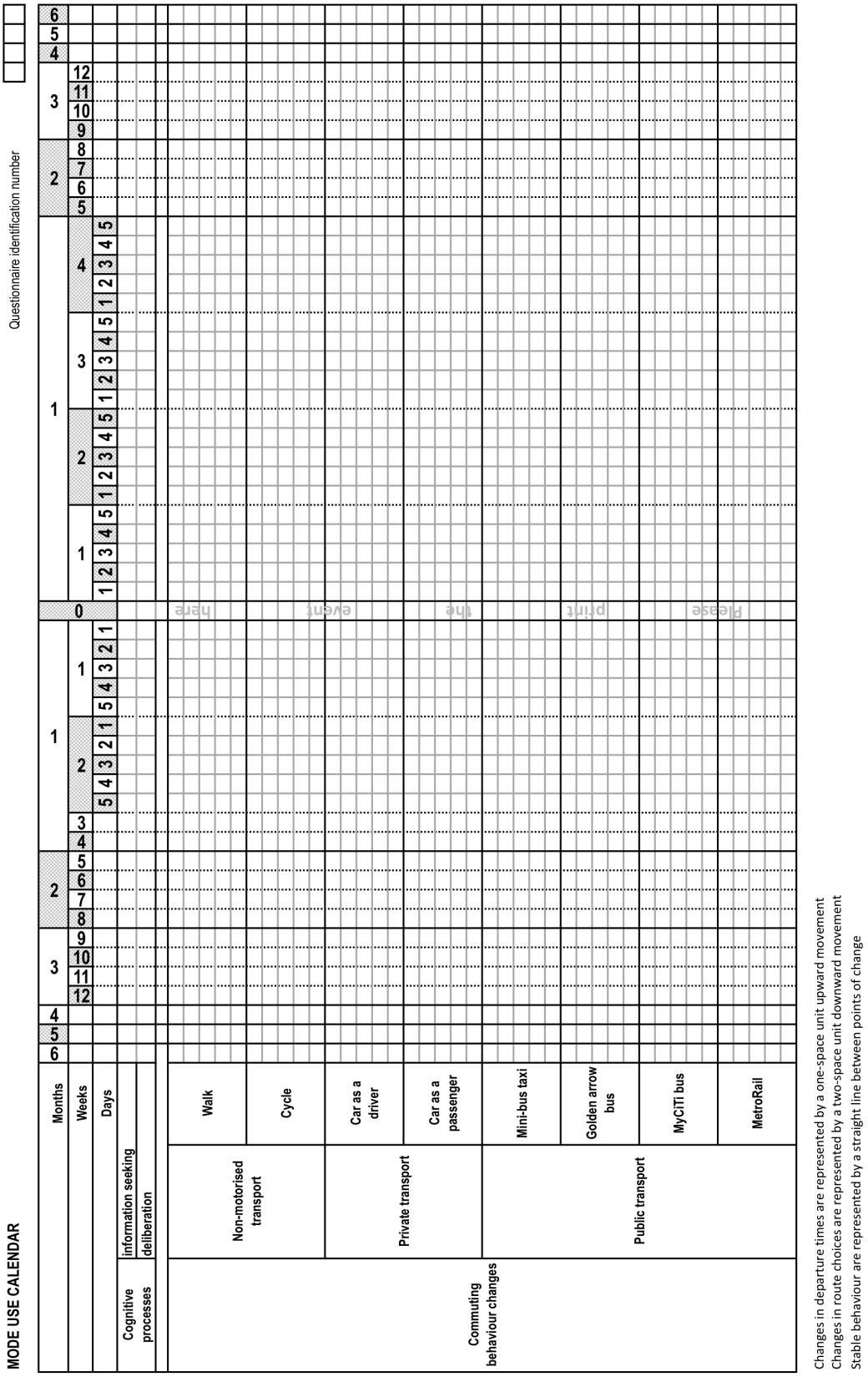
11. Respondent's Information *(to be filled in by interviewer)*

11.1 **Respondent gender** ☐ male ☐ female

11.2 **Respondent race** ☐ Black ☐ Coloured ☐ White ☐ Indian ☐ Other, _____

Thank you very much for your time.

Appendix F: Deliberation Calendar



Appendix G: Ethics in Research Clearance – Mobility Biography Survey

EBE Faculty: Assessment of Ethics in Research Projects (Rev2)

Any person planning to undertake research in the Faculty of Engineering and the Built Environment at the University of Cape Town is required to complete this form before collecting or analysing data. When completed it should be submitted to the supervisor (where applicable) and from there to the Head of Department. If any of the questions below have been answered YES, and the applicant is NOT a fourth year student, the Head should forward this form for approval by the Faculty EIR committee: submit to Ms Zulpha Geyer (Zulpha.Geyer@uct.ac.za; Chem Eng Building, Ph021 650 4791).
NB: A copy of this signed form must be included with the thesis/dissertation/report when it is submitted for examination

This form must only be completed once the most recent revision EBE EiR Handbook has been read.

Name of Principal Researcher/Student: Eric Adjei Department: Civil Engineering

Preferred email address of the applicant: eric.adjei@uct.ac.za

If a Student: Degree: PhD Civil Engineering Supervisor: A/Prof. Roger Behrens

If a Research Contract indicate source of funding/sponsorship: ACET

Research Project Title: Travel Behaviour Dynamics, Encouragement and Measurement

Overview of ethics issues in your research project:

Question 1: Is there a possibility that your research could cause harm to a third party (i.e. a person not involved in your project)?	YES	NO
Question 2: Is your research making use of human subjects as sources of data? If your answer is YES, please complete Addendum 2.	YES	NO
Question 3: Does your research involve the participation of or provision of services to communities? If your answer is YES, please complete Addendum 3.	YES	NO
Question 4: If your research is sponsored, is there any potential for conflicts of interest? If your answer is YES, please complete Addendum 4.	YES	NO

If you have answered YES to any of the above questions, please append a copy of your research proposal, as well as any interview schedules or questionnaires (Addendum 1) and please complete further addenda as appropriate. Ensure that you refer to the EiR Handbook to assist you in completing the documentation requirements for this form.

I hereby undertake to carry out my research in such a way that

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

Signed by:

	Full name and signature	Date
Principal Researcher/Student:	Eric Adjei Signature Removed	20th February, 2012

This application is approved by:

Supervisor(if applicable):	A/Prof. Roger Behrens Signaure Removed	20 Feb 2012
HOD (or delegated nominee): *Final authority for all assessments with NO to all questions and for all undergraduate research.*	Signature Removed	28/2/2012
Chair : Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions.	Signature Removed	5/4/2012

Appendix H: Ethics in Research Clearance – Deliberation Survey

EBE Faculty: Assessment of Ethics in Research Projects

Any person planning to undertake research in the Faculty of Engineering and the Built Environment at the University of Cape Town is required to complete this form before collecting or analysing data. When completed it should be submitted to the supervisor (where applicable) and from there to the Head of Department. If any of the questions below have been answered YES, and the applicant is NOT a fourth year student, the Head should forward this form for approval by the Faculty EIR committee: submit to Ms Zakiya Chikte (Zakiya.chikte@uct.ac.za); New EBE Building, Ph 021 650 5739). Students must include a copy of the completed form with the dissertation/thesis when it is submitted for examination.

Name of Principal Researcher/Student: Eric Adjei **Department: Civil Engineering**

If a Student: **Degree: PhD Civil Engineering** **Supervisor: A/Prof. Roger Behrens**

If a Research Contract indicate source of funding/sponsorship:

Research Project Title: Travel Behaviour Change Dynamics, Measurement and Encouragement

Overview of ethics issues in your research project:

Question 1: Is there a possibility that your research could cause harm to a third party (i.e. a person not involved in your project)?		NO
Question 2: Is your research making use of human subjects as sources of data? If your answer is YES, please complete Addendum 2.	YES	
Question 3: Does your research involve the participation of or provision of services to communities? If your answer is YES, please complete Addendum 3.		NO
Question 4: If your research is sponsored, is there any potential for conflicts of interest? If your answer is YES, please complete Addendum 4.		NO

If you have answered YES to any of the above questions, please append a copy of your research proposal, as well as any interview schedules or questionnaires (Addendum 1) and please complete further addenda as appropriate.

I hereby undertake to carry out my research in such a way that

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

Signed by:

	Full name and signature	Date
Principal Researcher/Student:	Eric Adjei Signature Removed	19th October, 2015

This application is approved by:

Supervisor (if applicable):	Roger Behrens Signature Removed	27 October 2015
HOD (or delegated nominee): Final authority for all assessments with NO to all questions and for all undergraduate research.	Signature Removed	
Chair : Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions.	signature Removed	24 Nov 2015